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VOL. XI, NO. 1 AUGUST, 1922

EDITORIAL

PROFESSOR EMMA SEREPTA YULE

In April Professor Yule left the College, on a year's well-earned leave. It is only after a useful member of the faculty has departed that we appreciate clearly, and in proper perspective, what we have lost.

Professor Yule joined the College in 1917, when there was a still greater discrepancy between number of teachers and number of students than at present, and when the burden of teaching was excessively heavy. She took up the work as she found it, cheerfully, and with the most genuine interest. Her personal interest in the students individually was always keen and helpful. The boys felt and appreciated this, and the response was ready and whole-hearted. So it is that a great teacher can get splendid and satisfying results where others might look at it as impossible and hopeless. With her many years of teaching experience, Professor Yule accepted the very difficult student material we have to handle as a constant challenge, and gave a large amount of time and thought to devising work and courses that would be specially and peculiarly adapted to our particular needs. Very different, this, from the attitude of some teachers who say "I teach it as it ought to be taught—if they don't get it, it is no fault of mine!"

In addition to her work as a teacher, Professor Yule carried a large amount of other work necessary to the operation of the College. For years she read all the senior theses for English—a very heavy burden. But it was a profitable burden to her, since out of it, and with the co-authorship of Dr. Trelease, grew the little volume on "The Writing of Theses and Technical Papers," which is now a standard for us and for many other institutions. A considerable order for this work recently came from Johns Hopkins University.

Professor Yule was also the English editor of the College Journal and always found time, somehow, to do the large amount of copy and proof work that this onerous task involved. She always carried home large bundles of theses, themes, copy, and proofs for night work.

Professor Yule's original work was largely confined to studies of oriental womanhood, and folklore, and her writings on these and kindred subjects are now well known, having appeared in the foremost magazines of America. Her point of view is an original one, and her style rich in individuality—and these combine to make her a successfu' writer on any subject that she attacks—and much in demand.

Professor Yule was of Scotch blood and Puritan stock; we will not forget the inflexibility of her opinions, and the finality of her judgments! But these same qualities helped to make her the great worker, the conscientious teacher, and the loyal college professor that she was. The College owes much to Professor Yule, and cannot afford to lose her.

CHARLES F. BAKER,
Dean, College of Agriculture

THE ANATOMY OF A DOUBLE PIG[1]

By MANUEL D SUMULONG
Of the Department of Veterinary Anatomy

WITH THREE PLATES

The specimen that is the subject of this paper was received by the writer on February 6, 1922, from Mr. Villadolid, graduate assistant in the Department of Entomology, College of Agriculture. It was presented to the department by a student about the middle of June, 1921, and preserved in 80% denatured alcohol containing little formalin. According to Mr. Villadolid the pig was born at full term and alive, but survived only for a short time.

With the exception of the distal third of the extremities, the pig was covered with black hairs. It weighed one hundred and ninety grams after having been preserved for about nine months. The right and left bodies were of equal length, being ten and a half centimeters each in crown-rump measurement. Undoubtedly, the pig was very much smaller than the rest of the litter. The average weight of normal, recently born native pigs is three hundred grams, and the average body length is sixteen centimeters.

According to Marchand's scheme of classifying malformations involving more than one individual, given by Bailey and Miller (1), double monsters fall into SYMMETRICAL DUPLICITY, where both bodies are equally developed and derived from originally similar and symmetrical anlagen within one ovum, and ASYMMETRICAL (PARASITIC) DUPLICITY, where one of the bodies, derived from originally dissimilar and asymmetrical anlagen, is always rudimentary and dependent on the other for its nutrition. Under symmetrical duplicity are included *complete duplicity*, in which the bodies may be distinct and separate, and *incomplete duplicity*, in which the bodies may be joined together to a greater or lesser extent. The present example belongs to incomplete duplicity, and falls readily into its subdivision, *syncephalus thoracophagus*, where there is a ventral union involving the head, neck and thorax.

The determination of the causative factors underlying the origin of complete or incomplete duplicities, has been, and still is, one of the most difficult and vexed problems of teratology, toward the solution of which many theories have been formulated. Among the theories are two decidedly opposed ones which have prevailed within recent years—the "fusion" theory and the "fission" theory.

Piersol (2) concisely and clearly explained these two theories as follows:

> "The present conception of fusion theory recognizes the presence of two originally distinct anlagen within a single ovum; these anlagen may remain separate and develop independently leading to the formation of twins, or they may come in contact during growth and undergo more or less external union, thereby producing some variety of double monster
>
> "The fission theory regards the duplicity as the result of cleavage of a single anlage during the very earliest stages of development, before the formation of the primitive streak The earlier the cleavage, the more complete the division of the anlage, or conversely, the longer deferred, the more incomplete the fission."

[1] Experiment Station contribution, No. 87.

The unusual presence of a large hepatic tissue traversing the median plane of the common abdominal cavity and connecting two small hepatic masses or lobes, the possession of a compound stomach, and the asymmetrical attachment of the costal cartilages to their corresponding sternum, as will be noted in the following description, may suggest that this double monster was in the process of fusion.

Although teratological literature is replete with descriptions of double monsters in the domestic animals, yet the writer was not able to find a single syncephalic case recorded that the anatomical peculiarities coincide entirely with those of the monster pig here studied. Of the syncephalic cases, to which he had access, two that show close resemblance to the specimen here presented will be described.

E. Carey (3) dissected a double pig presenting the following characteristics: The head was compound with a ventral compound face and a dorsal rudimentary one; presence of four nostrils on the snout. The mesio-cephalic aspect of the fused heads presented a hairless oval pit indicating the end of the proboscis of a cyclops. There were dorsal and lateral pairs of ears; those of the dorsal pair were smaller and found close together at the base of the skull. The bodies were joined venter to venter and the fusion extended backwards to the umbilicus. Only a single umbilical cord with four arteries and two veins was present. There were two sets of anterior limbs; and ventral and dorsal pairs of lungs, each of which was connected by a trachea to its corresponding larynx. The tongue was compound and the alimentary tract was single to within sixteen centimeters of the caecum, at which point the ileum bifurcated. The liver, pancreas, spleen, and the genito-urinary system were double. The right thyroid gland was absent from its normal position in the neck. There were dorsal and ventral hearts, each possessing a separate pericardium. Foramen ovale existed in each heart, and each right auricle received two anterior and one posterior vena cavae. Two complete cerebro-spinal axes were present; the fusion of the right optic nerve of the left encephalon and the left one of the right encephalon to form a common trunk represented the only connection between them.

The double pig described by Williams and Rauch (4) differed chiefly from Carey's specimen in the following respects: The head appeared more nearly normal, with but two ears and two nostrils. The dorsal side of the head showed a mass of wrinkled skin representing the rudiment of a face, under which was a fontanelle. The pharynx was divided by a connective tissue partition extending from its roof to the floor. There was but one spleen, one pancreas, and one liver. A fused heart with a single venous system and a large aorta to the body on the opposite side arising from each ventricle was present. The aorta from the right ventricle sent no branches further forward than the anterior limbs. There was a ventrally lobed lung mass with a single trachea. The cerebrum was single but the cerebellum presented three lobes. The medullas were fused anteriorly to each other.

It will be noted in the following text that the chief differences from above description by Carey will be encountered in the nervous and blood-vascular systems; and from that by Williams and Rauch, in the blood-vascular system, especially in the heart, and in the respiratory organs.

A partial list of authors consulted is the following: Wymann (5); Pilcher (6); Mitchell (7); Wilder (8); Mall (9); Chauveau (10); Reese (11 and 12); Sisson (13); Tannreuther (14); Thuringer (15).

TOPOGRAPHICAL ANATOMY

(PLATE I, FIGS. 1 AND 2)

Like that of the specimen of Williams and Rauch, the head is single and appears normal in shape and size. The skin and hairs covering it show nothing unusual. The snout has but two nostrils, and the face is well developed and bilaterally symmetrical, presenting no indication that it is of double origin. There are two fully developed lateral ears and a dorsal rudimentary one (1, Figure 1.) The latter is located at the highest point of the head and consists of a fold of skin, somewhat bean-shaped in outline, the free upper border of which is notched, indicating the fusion of the right external ear of the left body and the left external one of the right body. Dissection of this rudimentary ear and its underlying tissues revealed the absence of the corresponding middle and internal ears.

Upon palpation of the dorso-medial surface of the head, a little above the roots of the supraorbital processes, a rather soft area, free from underlying bone, was detected; and upon dissection there proved to be an irregularly oval opening, due to the failure of the parietal bones to fuse in the median line, and that the skin covering it was intimately adherent to the dura matter of the cerebrum.

There are present ventral and dorsal sets of fully and equally developed anterior limbs. The shoulder of each ventral anterior limb is closely applied to the angle of the jaw on the corresponding side. On the other hand, the shoulders of the dorsal anterior limbs are very much approximated to each other in the mid-dorsal line, forming the highest point (2, Figure 1) of the back of the animal.

The bodies are joined by their ventral aspects, and the union extends from before backwards to the common umbilicus, from which point caudad the two separate bodies are perfectly normal. There is present but a single umbilical cord (1, Figure 2) with four arteries and only one large vein.

INTERNAL ANATOMY

THE RESPIRATORY SYSTEM

(PLATE II, FIG. 1)

The thoracic cavity, which is common to both right and left bodies, is separated from the abdominal cavity by a single diaphragm. The latter structure is pierced by four foramina—left hiatus aorticus, right hiatus aorticus, foramen venae cavae, and a large foramen through which pass parts of the abdominal organs into the thorax, thus presenting a condition known as diaphragmatic hernia.

Two pairs of lungs, ventral (1) and dorsal (2) are present. Each pair is connected by an abnormally short trachea to its corresponding larynx. The right lung of the ventral pair corresponds to the right side of the right body and the left one, to the left side of the left body; the reverse holds true with the lungs of the dorsal pair, viz., the right lung, to the left side of the right body and the left one, to the right side of the left body. Only the lungs of the ventral pair are lobulated, having three lobes on the right and two on the left.

The dorsal larynx (3) is about half the size of the ventral one (4), and its dorsal aspect is directed ventrad instead of dorsad. Thus the epiglottic cartilages (epiglottes) of the dorsal and ventral larynges, when viewed thru the mouth, are

seen to have their pharyngeal or posterior surfaces directed toward each other. The thymus is apparently normal for a single individual. There is not a single thyroid gland present in the normal position in the neck.

Examination of the oral cavity revealed the presence of "cleft palate," due to the failure of complete development and fusion of the palatine processes of the maxillary bones. Besides, there was seen a globular mass of tissue, about one-half centimeter in diameter, attached by a short stalk to the median line of the posterior part of the roof of the bucco-nasal cavity, at the level of the tip of the dorsal epiglottis. Upon dissection the stalk was found perforating the body of the sphenoid bone at its middle and connected to the ventral surface of the brain. Section of the globular mass of tissue proved that it was pituitary body.

THE DIGESTIVE SYSTEM

(Plate II, Fig 1)

The tongue was single, and presented numerous and abnormally large villiform projections at the border of the tip and a mediam ridge which fitted into the cleft palate. About one centimeter behind the central circumvallate papilla, there was seen a club-like structure, about one centimeter in length, which upon section proved to be thyroid gland.

The stomach is compound, and consists of two unequal divisions, right and left. The division is indicated externally by a longitudinal constriction. Possibly this may suggest that the stomach is of double origin, viz., the fusion of the stomach of the right body and that of the left one. The right division (5) is larger than the left one (6) and is compressed from before backward; into it opens the oesophagus (7) which lies a little to the right of the median plane. The left division curves forward and passes through a large foramen in the diaphgram into the thoracic cavity. Undoubtedly, this condition was brought about by the pressure exerted by the developing liver. To the greater curvature of the small (left) division is attached the ventral spleen (8).

The small intestine leaves the middle of the posterior wall of the stomach almost exactly at the region of the constriction; its pyloric opening lies entirely to the left of the median plane. It makes twenty-six coils, mostly transverse, before it bifurcates, and its length from its origin to the bifurcation (9) is thirty-seven centimeters. Each of the branches has a length of fifteen centimeters and makes nineteen coils before it terminates into its corresponding caecum, which is the beginning of the large intestine. From the caecum (10) to the anus each of the two separate large intestines is normal for the corresponding body; and it is measured seventeen centimeters in length and makes fifteen coils.

The liver is single, and presents but three masses or lobes which are called here--the right dorsal (11), ventral (12) and left dorsal (13); the ventral lobe is considerably the largest. It is abnormally large for a single individual and occupies a very unusual position. It extends from the diaphragm anteriorly to the region of the umbilicus posteriorly, and fills almost the entire lower third of the compound abdominal cavity. Dorsally it is related to the intestines and ventrally, to the abdominal wall to which it has no attachment. The large umbilical vein (14) serves as its only attachment to the umbilical region. The anterior portion of the left dorsal lobe accompanies that portion of the stomach that projects into the thoracic cavity, as already referred to above. The gall-bladder is absent, and

the bile duct (15) opens into the duodenum about four and a half centimeters from the pylorus.

There is but one pancreas (16). It is situated on the left side of the right body, to the wall of which it is closely applied. It is attached to the dorsal wall of the right division of the stomach by connective tissue strands. The pancreatic duct (17) opens directly into the stomach, and its opening is guarded by two rudimentary valves.

THE URO-GENITAL SYSTEM

Upon examination of the fairly well developed external genitalia, both bodies proved to be female; this being verified by dissection. The uro-genital organs are double and normal for each body.

THE BLOOD-VASCULAR SYSTEM
(Plate II, Fig 2)

The hearts.– There are two hearts present, each of which possesses a distinct and separate pericardium. The ventral heart (1) is muscular and well developed, and is twice as large as the dorsal heart (2) which is only membranous in structure. They both lie entirely in the median plane; the dorsal being related to the roof of the thorax and the ventral, to its floor. The anterior surface of the ventral heart projects beyond the anterior borders of the first ribs, and is related to the thymus masses. Its unusually blunt apex lies opposite the articulation of the third and fourth sternebra.

The auricles of the dorsal heart are distinct but unequal in size, the right auricle being the larger. They are completely separated by a thin membranous partition and communicate freely with the ventricles by means of the right auriculo-ventricular foramen, which is guarded by three very rudimentary valves, and the left auriculo-ventricular foramen, which presents no indication of valve. The ventricles intercommunicate due to the failure of the development of the interventricular septum.

The ventral heart presents comparatively small auricles which are, however, apparently normal in structure. They are connected by a rather wide foramen ovale, due to incomplete development of both septum primum and septum secundum. There is no blood vessel communicating with the left auricle. The wall of the right ventricle is as thick as that of the left one, otherwise the ventricles are normal.

The principal arteries.—Arising from the left ventricle of the ventral heart is a fairly good sized ascending aorta (3) which bifurcates one centimeter from its origin into a right and left aortic arches (4, 5), the left arch is much larger than the right one. The brachiocephalic artery is absent, so the right and left common carotid arteries and the brachial arteries of the right and left bodies arise separately from the aortic arch of their respective side. One-half centimeter beyond the point of bifurcation, the left aortic arch gives off the left common carotid artery (6) which terminates anteriorly in occipital and internal and external carotid arteries (7, 8, 9). The right common carotid artery (10) is much smaller in caliber than the left one, and is given off a little beyond the origin of the right aortic arch. It terminates anteriorly in similar fashion as its fellow on the other side. Almost opposite its origin the right aortic arch is joined by the ductus arteriosus (11) of the ventral heart, which is, in turn, joined by the

ventral pulmunary artery (12), just before it opens into the aortic arch. The right aortic arch is also joined by the ductus arteriosus (13) of the dorsal heart about one centimeter from its junction with the ventral ductus arteriosus. Upon dissection the ductus arteriosus of the dorsal heart proved to be completely obliterated at its origin, having no communication at all with the ventricular cavity. The dorsal pulmunary artery (14) joins it a little distance from its origin.

The right and left brachial arteries (15, 15′) of each body arise separately from their corresponding aortic arch, and before emerging from the thorax they give rise to the vertebral and internal thoracic arteries (16, 16′ and 17, 17′) of their respective side; the internal thoracic arteries are given off just before they turn around the anterior borders of the first ribs.

The coeliac branch (18) of the left descending aorta has no homonymous artery on the right one, and its principal branches ramify chiefly in the dorsal spleen. The blood supplies of the stomach, liver, pancreas, intestines, and ventral spleen are derived chiefly from the anterior mesenteric branches (19, 19′) of the right and left descending aortae (20, 20′). The renal arteries (21, 21′) and other branches arising from the aortae, although not represented in the figure, show no special characters. There are four umbilical arteries (22, 22′) present, each arising from its corresponding iliac or hypogastric artery (23, 23′).

The principal veins.—There are four veins emptying into the right auricle of the ventral heart—anterior vena cava (24), posterior vena cava (25) of the right body, and posterior vena cava (26) of the left body. The anterior vena cava returns to the heart the blood from the right side of the head and neck and the anterior limbs and part of the thoracic wall of the right body. It is formed by the confluence of the right external jugular (27) and the common trunk (28) formed by the union of the right and left brachial veins of the right body. The left external jugular vein (29) drains the left side of the head and neck and opens into the left posterior vena cava, a little distance before the latter pierces the ventral pericardium. Before entering the thorax, it is joined by the right and left brachial veins of the same side. The internal jugulars which are normally large in pigs are absent here.

The posterior vena cava of the right body receives the two hepatic veins (30), just before it reaches the foramen venae cavae of the diaphragm. The posterior vena cava of the left body passes thru the foramen hiatus aorticus in company with the left descending aorta. A little medial to its junction with the left external jugular vein, it is joined by another blood vessel arising from the right auricle of the dorsal heart; it is called here the anterior vena cava (31) of the dorsal heart. The renal veins and the common iliac veins (32, 32′) of both the right and left bodies present no special features of importance.

The abnormally large ductus venosus (33) is imbedded in the substance of the ventral lobe of the liver, connecting the large umbilical vein (34) and the hepatic veins. The portal vein (not indicated in the figure) enters the liver at a small depression on the dorsal surface of the ventral lobe.

The left auricle of the dorsal heart receives a large blood vessel which traverses the thoracic wall of the right side of the left body. Its principal branches ramify in the dorsal spleen and in the left dorsal portion of the diaphragm. This blood vessel is called here the "vena hemiazygos" (35).

THE SKELETON

(PLATE III, FIG. 1)

The bones of the extremities, anterior and posterior, are all fully and equally developed and show no special characters that deserve attention. There are present two vertebral columns, each of which presents the normal number of vertebrae and articulates anteriorly with the occipital and temporal bones of the corresponding side of the skull. The comparatively short bodies and spinous processes of the last four cervical vertebrae are more or less fused, which possibly may explain the relative shortness of the neck.

The thorax is compound. It is bounded by fifty-six well developed ribs which constitute the normal number for two individuals. There are two sterna, dorsal and ventral; the latter is much better developed. The dorsal and ventral chondro-sternal articulations are rather asymmetrically arranged, viz., those of one side are not found exactly opposite those of the other. This condition may readily suggest that each sternum was formed by the fusion of the parts of the sternum of the right body with their corresponding parts of that of the left one.

The skull is apparently normal in size and shape, and presents the normal number of bones that make up the skull of a single individual. Of the cranial bones, the parietal and occipital only present special features that deserve notice. The former fails to meet and fuse with its fellow on the opposite side, thus creating an irregularly oval opening (1) into the cranial cavity; and the latter fails to develop with the parietal the nuchal crest which is very prominent in normal pigs. The foramen magnum (2) is abnormally small and closed by a fibrous connective tissue membrane which is firmly attached around its margin.

THE NERVOUS SYSTEM

(PLATE III, FIG. 2)

The peculiarities of the central nervous system of this monster pig coincide almost entirely with the description by Williams and Rauch. The cerebrum (1) is single, presenting on its dorsal and lateral surfaces indistinct gyri and sulci which are very irregularly arranged. The optic nerves and the olfactory bulbs (2) are normal for a single individual.

The cerebellum (3) shows distinctly the right and left cerebellar hemispheres and the median vermis. The medullas (4, 4′) are partly united anteriorly, otherwise the remainder of the cerebro-spinal axes is normal for each body.

ACKNOWLEDGEMENT

The writer wishes to express his sincere thanks to Mr. Deogracias Villadolid of the Department of Entomology-Zoology for the privilege of dissecting the pig here recorded.

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ILLUSTRATIONS

PLATE I

Fig. 1 Dorsal view of the monster

Fig. 2. Ventral view of the monster

PLATE II

Fig. 1. Ventral view of the respiratory and digestive systems; the lungs, stomach, and pancreas are $^3/_4$ of their actual size.

Fig. 2. Ventral view of the blood-vascular system with the dorsal heart (2) so reflected that its dorsal aspect is seen in the figure. The hearts are $^3/_4$ of their actual size

PLATE III

Fig. 1. Dorsal view of the skeleton without the dorsal anterior extremities

Fig. 2 Dorsal view of the cerebro-spinal axes.

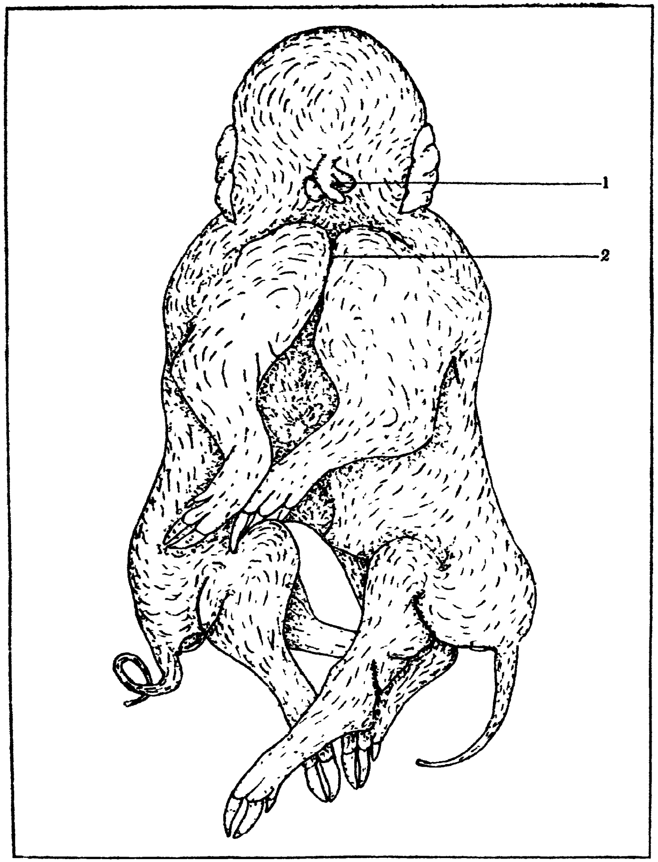

Fig. 1. Dorsal view of the monster.

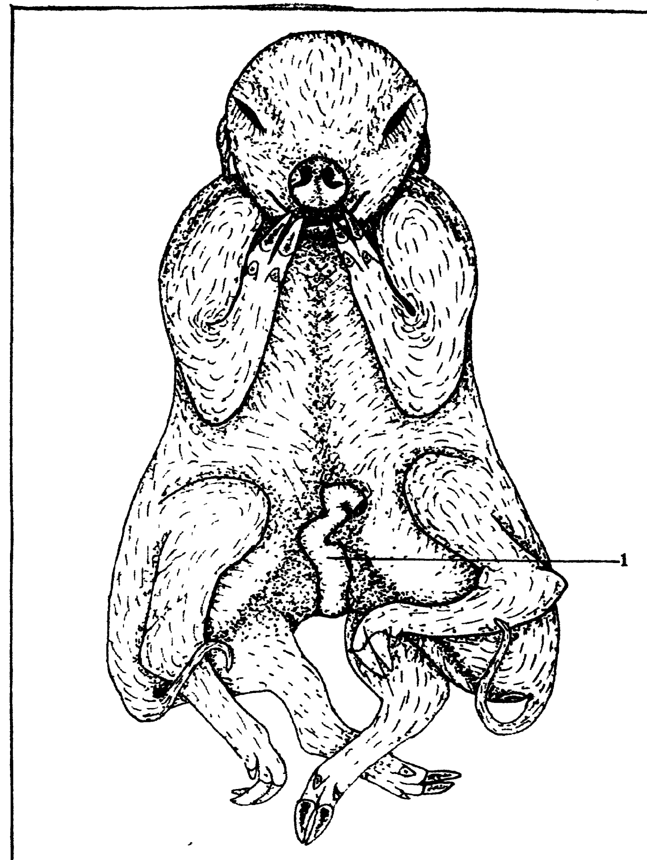

Fig. 2. Ventral view of the monster.

PLATE I

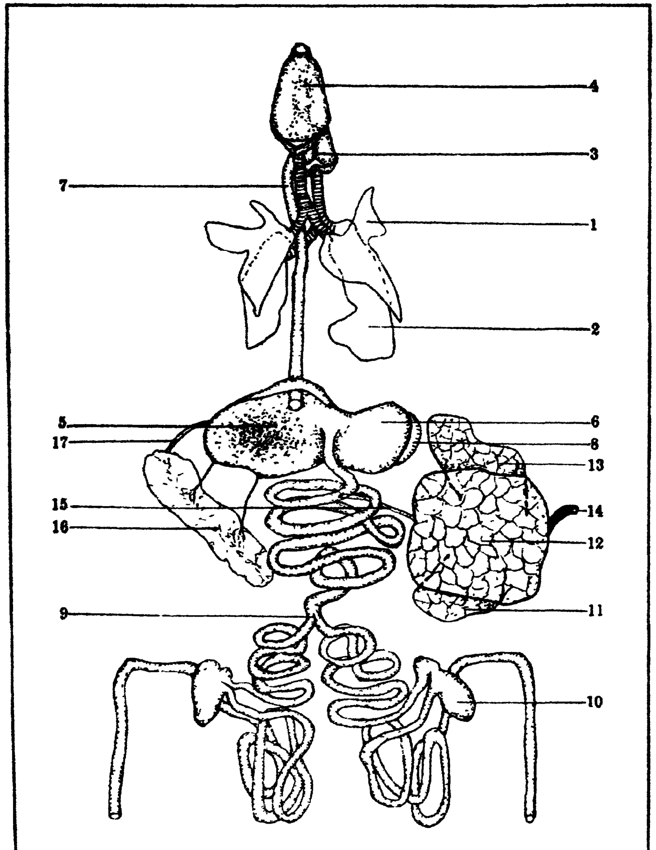

Fig. 1. Ventral view of the respiratory and digestive systems.

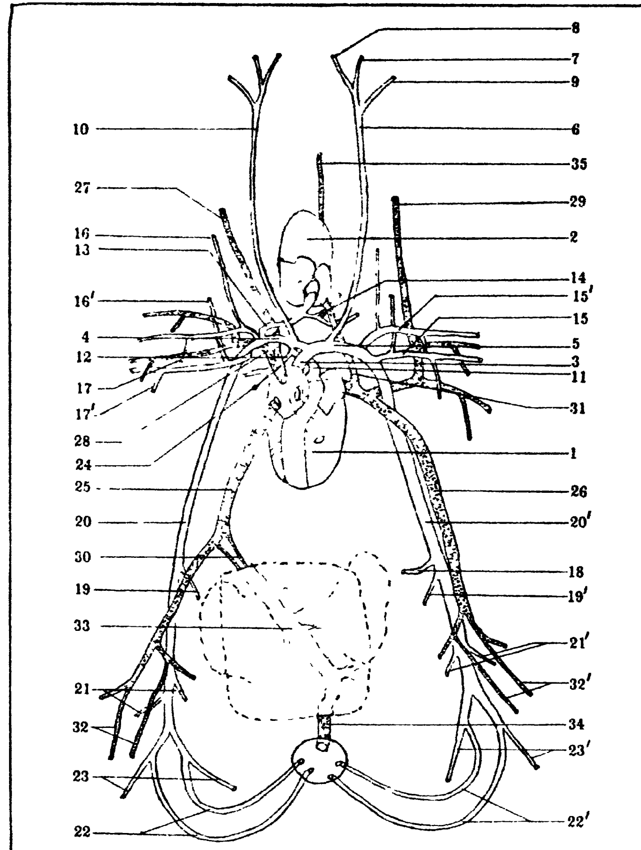

Fig 2. Ventral view of the blood-vascular system.

PLATE II

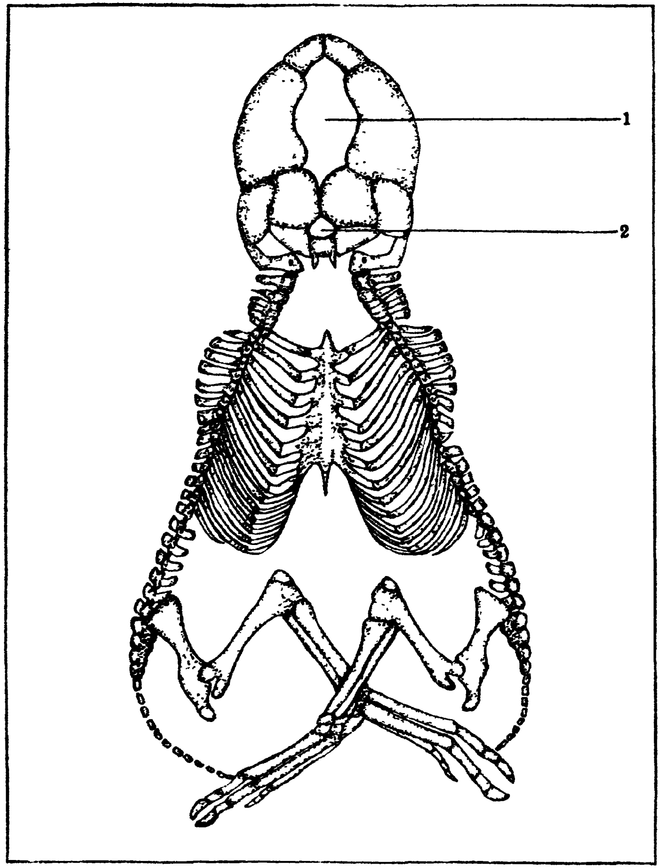

Fig. 1. Dorsal view of the skeleton.

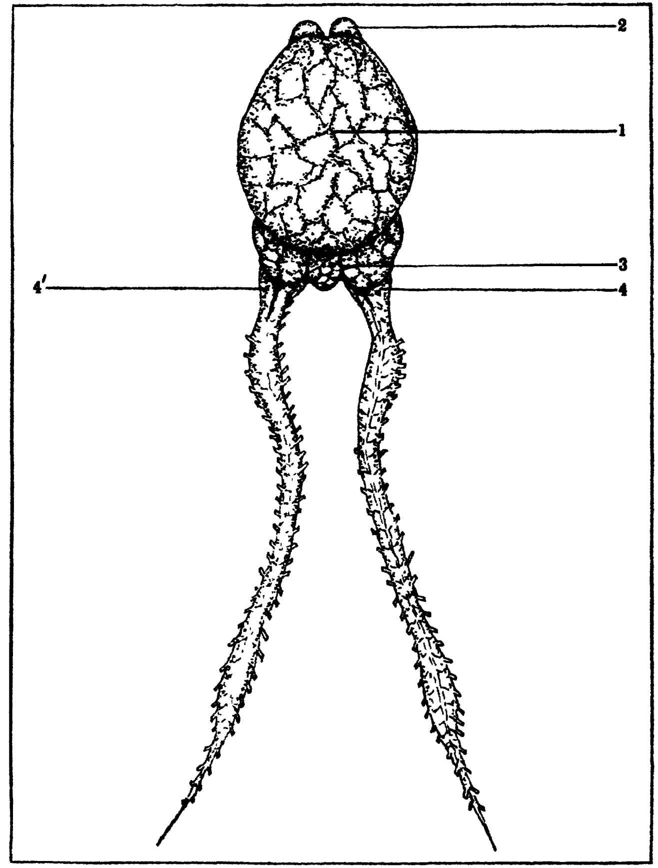

Fig. 2. Dorsal view of the cerebro-spinal axes.

PLATE III

CYANOPHORIC PLANTS OF THE MAKILING REGION[1]

By D. A. Herbert

Of the Department of Plant Physiology

That hydrocyanic acid is widely spread through the plant kingdom is a well known fact. Greshoff (1) working at Kew and Haarlem has drawn up a long list of cyanophoric plants belonging to widely separated families. Similar work is at present being carried out by Smith and White (2) (3) in Queensland, where a systematic examination of the flora is being made. Such work is valuable from an economic standpoint in affording an indication of possible losses of stock from eating these plants, and the present paper is a contribution towards the local study of the subject. It is not an exhaustive list even for the limited area with which it treats, but the common native species, introduced fodder and food plants, ornamental plants and weeds have been dealt with. Most of the examinations were made by graduate students working under supervision on a course of plant nutrition at the College of Agriculture during the summer of 1922.

A point to be noted is that the amount may vary greatly in different individuals of the same species. Further, the method of testing is important, and must be sufficiently delicate to produce a reaction in the presence of very small amounts, as in the case of the majority of plants examined the percentage of hydrocyanic acid is very low. Two modifications of Guignard's test were used; first, the hanging of a strip of moistened sodium picrate paper in a tube containing the material, and second, the immersion of the material in sodium picrate solution to which a little chloroform had been added. A large number of plants though giving rather rapid reactions with the second method were either extremely slow or did not give any reaction with the test papers. Those with a higher percentage showed a positive reaction readily with the sodium picrate paper, but when there was only a trace of hydrocyanic acid present the method was not successful in a large number of cases. As examples the following plants may be cited: *Mimosa pudica*, *Bauhinia malabrica*, *Cyperus rotundus*, *Dillenia indica*, *Phaseolus lunatus*, *Cecropia palmata*, *Caryota cumingii*, *Citrus decumana*, *Mangifera indica*, and most of the palms examined. A reaction which showed on the test paper only after several hours exposure was shown in a few minutes by the method of immersion of the tissue being examined.

Where the material was available, roots, stems, leaves, flowers, and fruits were examined and the results show considerable variation in amount. The following is the list of plants examined, and it will be seen that the majority proved to be cyanophoric in a greater or lesser degree.

ACANTHACEAE

Graptophyllum pictum (Marado): Slightly positive in bark, flowers, and leaves.

Amaranthus spinosus: The leaves contain traces of hydrocyanic acid, but those of *A. viridis* (Colites) contain none.

[1] Experiment Station contribution, No. 88.

ANACARDIACEAE

Buchanania arborescens (Balinhasay): Stem and leaves positive, a large amount being present in the leaves.

Mangifera indica (Mango): Bark positive, leaves negative.

ANONACEAE

Anona muricata (Guanabanos): All parts positive especially the bark which contains large amounts of hydrocyanic acid. The leaves contain rather less, the roots less and the fruits only a trace.

Anona reticulata (Anonas): The content was lower in this species. Fruits were not available for examination. The distribution in the bark, roots and leaves was somewhat different from that in *A. muricata* the greatest amount being in the bark, the next in the roots, whereas in the leave it was only in minute traces.

Canagium odoratum (Ilang-ilang): Slightly positive in bark, flowers and leaves.

APOCYNACEAE

Taternaemontana subglobosa (Pandakaki): Leaves and bark faintly positive, flowers negative.

ARACEAE

Alocasia indica (Biga): A slight trace in the tuber, none in petiole or leaf.

Alocasia macrorrhriza (Wild Gabi): Negative in all parts.

Alocasia portei (Biga): Negative.

Alocasia sanderiana (Wild Gabi): Slightly traces in tuber and petiole; none in the leaf.

Caladium bicolor (Ornamental Gabi): Negative.

Colocasia esculentum (Taro): Negative.

Colocasia zebrina (Ornamental Gabi): Positive in all parts; more so than the other members of the family listed.

Xanthosoma sagittifolium (Wild Gabi): Very slight traces in tubers, petioles and leaves.

ARTOCARPACEAE

Artocarpus integrifolia (Jak-fruit): Bark and leaves faintly positive.

BALSAMINACEAE

Impatiens balsamina (Camantique): A trace in the flowers, slightly more in bark and leaves.

BIGNONIACEAE

Spathodea campanulata: Bark, leaves, and roots positive.

CARICACEAE

Carica papaya (Papaya): Hydrocyanic acid absent from all parts of the papaya including the fruit.

CELASTRACEAE

Spondias lutea: Slightly positive in bark and flower, but negative in the leaves.

COMBRETACEAE

Quisqualis indica: Slightly positive in the leaves, more so in the bark.

COMPOSITAE

Erigeron linifolius: Leaves and roots slightly positive; bark negative.

Vernonia cinerea and *V. patula:* Both these species showed traces in all parts.

CONIFERAE

Agathis alba: Leaves gave a faint reaction.

Cryptomeria japonica: Negative.

CONVOLVULACEAE

Ipomea batatas (Camote): Traces in stem, leaves, fruits and roots; in some cases absent altogether.

Quamoclit acutangula (Cabello del angel): Positive in leaves, a faint trace in stem, flowers, roots, negative in fruits.

CUCURBITACEAE

Cucurbita acutangula: Positive in leaves, a faint trace in stem, flowers and roots, negative in fruits.

C. cylindrica: Negative.

C. maxima: Faint traces in stems leaves and roots, but flowers and fruits negative.

C. pepo: Negative in fruits.

CYPERACEAE

Cyperus rotundus: Positive in leaves, stems, roots and rhizomes.

DILLENIACEAE

Dillenia indica (Catmon): Slightly positive in the leaves.

EUPHORBIACEAE

Bischofia javanica: Leaves faintly positive; some negative.

Codiaeum variegatum (San Francisco): Bark and leaves positive the former containing the greater quantity.

GRAMINEAE

Andropogon citratus: Traces in leaves, roots.

Cynodon dactylon (Bermuda Grass): Traces in leaves, stems and roots.

Dactyloctenium egypticum: Negative.

Digitaria consaguinea: Traces in leaves, stems and roots.

Imperata cylindraca (Cogon): Traces in leaves and stems.

Leersia hexandra (Zacate): Traces in leaves and stems, with rather greater quantity in roots.

Oryza sativa (Rice): Very faint traces in stems and leaves, slightly more in the roots.

Panicum maximum (Guinea Grass): Traces in stems and leaves; rather more in roots.

Panicum crus-galli (Balili): Slight traces in all parts.

Paspalum dilatatum (Para Grass): Positive in all parts, and containing more than the other grasses examined.

Saccharum officinarum (Sugar Cane): A very faint trace.

Saccharum spontaneum (Talahib): Positive in all parts, the leaves containing most, the stems less and the roots least.

Zea Mais (Maize): Positive in all parts but only a faint trace in the stem.

LAURACEAE

Cinnamomun camphora (Cinnamon): Faint trace in bark and leaves.

Litsea glutinosa: Bark, leaves and roots positive.

Persia gratissima (Avocado): Bark positive, a faint trace in the leaves and none in the fruit.

LEGUMINOSAE

Abrus precatorius (Saga-saga): Stems, leaves, and roots positive.

Acacia farnesiana (Aroma): A faint trace in stems, leaves and roots.

Albizzia procera (Aleng parang): A faint trace of absent.

Bauhinia malabarica (Alibangbang): Traces in the nature undried seeds; none in the dried.

Caesalpinia pulcherrima (Caballero): Positive in leaves, stem and roots.

Cajanus indicus (Cadios): Traces in leaves, stems and roots.

Canavalia ensifomis (Sword Bean): Negative.

Cassia alata: Positive in leaves, stems and roots.

Centrosema plumieri: Positive in the stem and roots, but faint traces only in other parts.

Desmodium scoprrus: Traces in the leaves and still less in the stem, negative in the roots.

Derris philippinensis: Positive in bark, leaves and roots.

Dolichos lablab (Batao): Traces in leaves, stems and roots of both white and pink forms; a very definite reaction given by the seeds.

Erythrina indica (Dapdap): Traces in leaves, stems and roots.

Ghricidia sepium (Madre cacao): Faintly positive in the leaves, but more so in the bark and roots. The leaves also contain a fair amount of the volatile aldehyde coumarin, especially in the young stage. Some plants gave negative tests throughout.

Intsia bijuga (Ipil): A slight trace in the leaves. None at all in the bark.

Leucaena glauca (Ipil-ipil): Leaves, stems and roots contain traces.

Mimosa pudica (Macahia, Sensitive plant): Roots, stems and leaves positive, the roots containing most, the stems less, and the leaves still less.

Pachyrrhizus crosus: Traces in bark, leaves and roots.

Parkia timorana (Cupang): Bark, leaves and roots positive.

Phaseolus lunatus (Patani): Well marked reaction from the stem. A trace in the leaves and none in the roots. The mature seeds contained a large quantity of prussic acid. This is not in keeping with the findings of Dunstan that *Phaseolus* lunatus produces prussic acid only in the wild state and loses it either entirely on except for a minute trace when it is cultivated. No wild plants were available for examination.

Pithecolombium dulce: Traces in bark, leaves and roots.

Psophocarpus tetragonobolus: Positive in the stems but with traces only in leaves and roots.

Tephrosia candida: All parts negative.

Vigna sesquipedalis: Negative.
Vigna sinensis: Negative.

LILIACEAE

Cordyline terminalis: Negative.

LOGANIACEAE

Strychnos nux-vomica (Strychnine): Positive in leaves, bark and roots.

MALVACEAE

Hibiscus rosa-sinensis: Negative in all parts.
Thespesia populnea: Negative in all parts.

MELIACEAE

Swietenia macrophyla (Mahogany): Varying amounts from a faint trace to fairly strongly positive. The leaves always with more than the bark.

MORACEAE

Cecropia palmata: Traces in leaves and fruits, more in the bark.

MYRTACEAE

Eugenia jambolana (Duhat): Negative in bark, leaves and roots.

NYCTAGINACEAE

Bougainvillea spectabilis Negative.

ORCHIDACEAE

Vanilla planifolia: Negative.

PALMAE

Areca catechu (Betel Palm). Positive in leaf, stem and root; traces in the fibrous pericarp, but the mesocarp strongly positive.

Arenga pinnata (Cabo negro)· Positive in the stem; traces only in fruit, flower, leaf and root.

Calamus sp. (Rattan): Traces in all parts.

Carludovica palmata (Panama Palm): Slight traces in all parts

Cocos nucifera (Coconut): Strongly positive in the stem and the pericarp, and definitely positive in other parts.

Corypha elata (Buri Palm): Slight traces in all parts.

Dypsis madagascariensis: Slight traces in all parts.

Livistona rotundifolia (Anahao): Slight traces in leaves, stems and roots.

Normanbya merrillii (Bunga de China): Slight traces in leaves, stems and roots.

Oreodoxa regia (Royal Palm): Positive in stems and roots; traces in the leaves.

Phytelephas macrocarpa: Slight traces in leaves, stems and roots.

Ptychosperma macarthurii: Slight traces in leaves, stem and roots.

PASSIFLORACEAE

Passiflora rectangularis: Negative.
Passiflora quandrangularis: Negative.

PHYTOLACCACEAE

Phytolacca oleraceus: Negative.

PIPERACEAE

Piper belle (Betel pepper): Positive in the leaves, but very faint in other parts, including fruits.

POLYGONACEAE

Antigonon leptopus (Morning Glory): Negative.

PROTEACEAE

Grevillea robusta (Silky Oak): Positive in leaves, bark, root, more in the leaves than in the other parts. Smith and White examined this plant in Queensland, its native country, and found the foliage to give negative reactions. They also examined the flowers and seed, but the Makiling plants did not possess these and it remains to be seen if the these parts vary also in their prussic acid content.

ROSACEAE

Eriobotrya japonica: Negative in the fruit; slight traces in the bark and leaf.

RUBIACEAE

Coffea liberica (Coffee): Leaves and bark positive; roots negative.

RUTACEAE

Citrus aurantium, *C. decumana*, *C. limonis*, *C. mitis* and *C. nobilis* contain traces in bark, leaf, and fruit, *C. hystrix* and *C. trifoliata* have traces in the leaf, but none in the bark.

STERCULIACEAE

Sterculia carthaginensis: A trace in the bark and the leaves.

URTICACEAE

Laportea subclausa (Lipa): Strongly positive in leaves, bark and roots.

VERBENACEAE

Tectona grandis (Teak): Bark negative, leaves faintly positive.

From these results it will be seen that the distribution of hydrocyanic acid in different parts is not uniform, even in species belonging to the same genus (see *Anona*); that is, no part is found to contain more than the other parts in all the species examined. In the majority of cases the greatest amount is in the bark, but in by no means all. The amount also depends on individuality to a great extent, and locality play an important part. *Swietenia macrophylla* is a good example showing variation within a small area, and *Grevillea robusta* shows how the content may vary when the same species is raised in different countries.

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THE PARASITISM OF OLAX IMBRICATA[1]

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ONE TEXT FIGURE

Olax imbricata, Blume (Malabaguio), is a large woody vine occurring sparingly in Mount Makiling. Phylogenetically the family Olacaceae comes very close to two notoriously parasitic families, the Loranthaceae and the Santalaceae. Most of the Loranthaceae are parasitic on branches, but one genus, Nuytsia (1), is a root parasite. The Santalaceae contain no members parasitic on branches, but a large number, and probably all, have been shown to be root parasites (2), (3), (4), (5). It is, therefore, to be expected that a similar property might be exhibited by the Olacaceae, and one member, *Olax scandens*, has been proved by Barber (6) to possess root attachments.

In appearance there is nothing in this species to suggest a heterotrophic habit. Its leaves are well developed, and were it not for its systematic relationships it might pass as a holophytic plant. An examination of its roots, however, shows that it is definitely parasitic. The root system is shallow and wide, the large rather soft roots branching and ultimately giving rise to fragile white roots which in contact with another root produce a lateral haustorium. This is of the same type as that found in the Santalaceae, and attains about the same size as that of *Fusanus spicatus* or of *F. acuminatus*. The shape of the mature haustorium is approximately like that of a mushroom with the pileus external to the host root, the gills pressed against the surface of it, and the stipe embedded in the tissue external to the wood. The position of the vascular tissue in the haustorium corresponds roughly to that of a layer several millimeters from the surface of the haustorium, i.e., it is in the shape of an inverted flask; the mouth of the flask being in contact with the wood of the host root. The *Olax* haustorium, therefore, obtains salts and water as well as organic matter from the host plant.

In a large *Olax* plant it is obvious that any particular root will have more chance of coming into contact with other roots of the same plant that with those of other species. This happens more particularly round the base of the plant where the root system is more centralized, and in this region a large number of haustoria are found on *Olax* roots. Self parasitism is the rule in root-parasitic plants, and *Olax* is no exception. There is no used to trace these roots back to the parent plant; they are very distinctive, soft and inclined to be fleshy, and devoid of root hairs.

The functional existence of the haustoria is limited. As the root grows they are forced outwards and perish, and scars are left to mark their point of attachment. They are invariably lateral in the specimens obtained, and this lends support to the theory that they are organs as distinct as leaves or flowers, and not modified roots.

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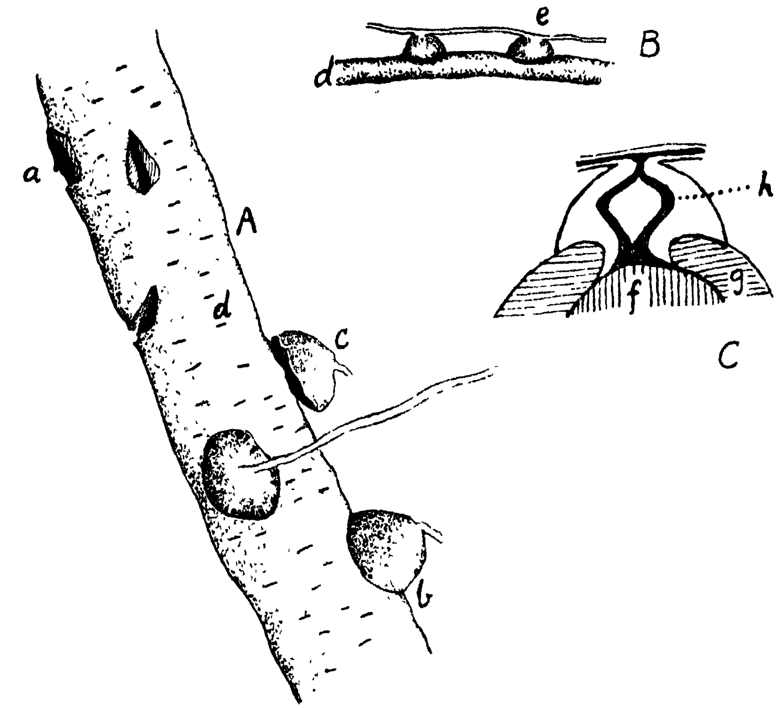
[1] Experiment Station contribution, No. 89.



PARASITISM OF OLAX IMBRICATA

A. Root of *Olax imbricata* attacked by its own haustoria
- a Scar left after death of haustorium,
- b Mature haustorium really originally lateral but apparently terminal through death of distal portion of the root
- c. Old haustorium being forced off by the growing root
- d. Host root

B. e. Young haustoria showing lateral origin

C. Section of haustorium attacking root (diagrammatic).
- f. Host wood.
- g Host cortex.
- h Vascular tissue of haustorium

There are three host plants found and two of these were legumes. The best development of haustoria, however, was found on the roots of *Olax* itself. Evidently the food material supplied by these is more nearly what the plant requires, and, therefore, haustoria reach their maximum development when attached to them.

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STUDY OF BUD VARIATION IN CODIAEUM VARIEGATUM[1]

By Nemesio B. Mendiola and Juan R. Magsino

Codiaeum variegatum (L.) Blume is a horticultural species to which has been applied the Filipino common names, San Francisco, Buenavista and Saguilala, and the English name, croton. According to Merrill[2] this species is, in respects to form and color of the leaves, the most variable in the Archipelago. A study of the variability in this species should prove of genetic and horticultural interest. Such a study might lead to a knowledge of the causes of such great variability and to a discovery of the way in which new types may be produced.

An ornamental so common and so widely distributed in the Philippines as this species deserves some attention in regard to improvement, or the beautifying of old forms and the creation of new forms, or types.

This work consists, among other things, of a familiarization with different forms, or types of San Francisco, and a study of such bud variations as may be found. Other objects of this investigation are to determine whether the variants found give rise to permanent new forms or not and if permanent variations may be caused by variation in soil and light conditions.

This work was carried on in the College of Agriculture, University of the Philippines, Los Baños, beginning June, 1920, and ending July, 1922.

MATERIALS AND METHODS

All available varieties of *Codiaeum variegatum* growing on the College of Agriculture grounds as well as some varieties growing in Lemery and Taal, Batangas, were studied. General observations were also made of the varieties found in barrios of Los Baños, and in different sections of Manila. Sixteen varieties were described. The descriptions appear in Table I.

EXPERIMENTS AND RESULTS

CUTTINGS, BEDS, AND PLANTINGS

Thirty-six cuttings were obtained from each of the varieties used and made to root in a bed of medium sand soil in the upper College Nursery. The cuttings were made uniform, at a length of about 18 centimeters. After the cuttings rooted and produced about eight to ten pairs of leaves each they were transplanted to two groups of beds under two different sets of conditions. One group was under artificial shade and the other was exposed to direct sunlight from half past six o'clock in the morning to half past five o'clock in the afternoon. There were three beds in each group. One bed contained ordinary farm soil; the second, ordinary soil mixed with about an equal amount of sand; and the third, farm soil mixed with an approximately equal quantity of decomposed horse manure. Each bed was one half meter deep, and the cuttings were set about 30.5 centimeters

[1] Experiment Station contribution, No. 90. Thesis combining a thesis presented for the Degree of Bachelor of Agriculture by Juan R. Magsino, No 143.

[2] Merrill, E. D., A Flora of Manila, 490 pp , 1912 Bureau of Printing, Manila.

apart each way. Each of the six beds in the two sets was planted with six cuttings of each variety.

STUDY OF VARIATIONS

Two kinds of bud variations were observed in the species. One kind was in the general coloring and spotting of leaves, while the second was in the shape, or form of leaves. A very conspicuous example of the first was found in variety No. 16, and of the second, in varieties numbers 15 and 16. Modifications are common in most of the varieties in the species. The following variations were observed within individual plants:

Variety No. 1.—This produces branches that have various colored leaves. Some branches are almost all green in color while some are variegated with yellow coloration on the veins.

Variety No. 2.—This bears some branches with leaves very much smaller than the leaves produced by most of the branches.

Variety No. 3.—This variety has branches the leaves of which are heavily spotted with light yellow coloration. It also produces branches that bear leaves with only a slight spotting, yet appearing very much darker green. Sometimes some branches produce smaller sized leaves than others.

Variety No. 4.—Some branches have leaves that are all straight while other branches produce also leaves which are twisted and leaves which are slightly lobed in the middle.

Variety No. 5.—This variety sometimes produces leaves that are long and sharp pointed. The leaves on some branches have rounded ends. Some branches produce leaves that are less decorated with yellow coloration and thus they appear more green.

Variety No. 6.—This variety produces branches all of which are green. In general the leaves are heavily spotted with yellow.

Variety No. 7.—This produces branches which bear in general much smaller sized leaves than the others. They are shorter and narrower, and thus can be easily distinguished from the rest.

Variety No. 8.—Some branches of this variety yield leaves that are shorter and narrower than those of the general type.

Variety No. 9.—This produces branches that have shorter and narrower leaves than other branches have.

Variety No. 10.—Some branches of this variety produce leaves of a brilliant dark green, spotted with yellow, while others produce branches that are pale green with the same color spotting.

Variety No. 11.—There are observed branches that have leaves generally smaller than the leaves of other branches. Besides, the bright coloration of leaves found on some branches is absent on others. Some branches produce leaves that are entire.

Variety No. 12.—This variety possesses branches with green leaves at the apex, when in general more of yellow coloration is observed at this part.

Variety No. 13.—Some branches produce very dark green leaves, while in general the leaves produced by the branches are bright yellow, particularly those at the terminal portion. Some branches produce much smaller leaves than others.

Variety No. 14.—In this variety some branches have green leaves while others are tinted with yellow on the veins and on both upper and under surfaces.

Variety No. 15.—This variety looks just like a bud mutation produced by variety No. 6. This plant produces branches that have leaves which are more green than the others, due to the fact that they are less spotted with yellow. Besides, the leaves produced by some of the branches are shorter and narrower.

Variety No. 16.—This variety produces branches that bear all green leaves. This is an offspring of variety No. 6.

Variety No. 17.—This is practically the same as variety No. 15 except that here the yellow coloration on the leaves is very slight and the leaves thus appear generally green.

Variety No. 18.—This possesses some branches with straight leaves, and other branches with the leaves both straight and twisted.

Most of the variations described above are modifications and are not transmissible. This was shown by actual experiments of the Plant Breeding Class in this College and are to be supposed as merely due to differences in environmental factors. These variations have, therefore, not been a direct cause of the productions of new varieties in the period of this investigation.

BUD MUTATIONS

Only one variety was observed to produce bud mutations. This variety is No. 6. The mutation was observed in several plants,—in one plant grown in Lemery, Batangas, and in seven plants growing on the College Campus. One mutation consisted in the production of a lateral branch with longer and very much narrower leaves, like those of Variety No. 15. The other mutation consisted in the production of a branch with leaves still similar in shape to those of the parent variety but different in color, as the mutation is all green. The parent variety is green with small dots or spots of yellow. The first mutation, a change from short broad leaves to long narrow leaves is both lateral and terminal. Examples of the lateral and terminal bud sports are shown in Plate I, figures 1 and 2 respectively.

That the variations shown were mutations was proved by the fact that they grew true to type when cuttings showing variations in these two characters were cut from parent plants and planted.

A third bud variation observed in Variety No. 6, which variation is highly suspected as mutation, consists in a lateral branch with narrow leaves which tend to become a two-or three-part affair as shown in Plate II. The leaves vary in shape from that of the parent, becoming narrow in some and still narrower at the middle in others. Others are found with a tendril-like structure or the bare midrib coming out of the tip, the end of which tendril-like structure producing new leaves, to such an extent that a leaf may have three parts. This variation was discovered by Prof. Higgins on one of the plants on his yard.

DISCUSSION OF RESULTS

From the results of this work, it was found that bud variations were produced by subjecting the plants under various soil conditions. The plants were induced to form leaves of deeper color by manuring, and of lighter color by planting them in sand. Generally, those exposed to sunlight produced a brighter coloration of leaves than those kept under artificial shade. On the other hand

those under shade were taller, more slender and less branchy than the exposed individuals. Observations of bud modifications existing in the different varieties have shown that these varieties produce bud variations which are not heritable.

As has been previously explained, two kinds of bud mutations were found (a) lateral and a terminal bud mutations consisting in the production of longer and narrower leaves, and (b) bud mutation consisting in a branch with almost all-green leaves. These bud mutations were detached from their parent plants and planted as described. In either case, both kinds continued to grow true to type. An example of (a) is found in Plate I. This fact seems to indicate that the old variety No. 15 probably originated as a bud sport from variety No. 6.

SUMMARY AND CONCLUSIONS

1. Bud variations in the species *Codiaeum variegatum* were produced by manuring or by growing the plant in soil containing 50 per cent sand and 50 per cent ordinary farm soil, or by exposure to the sun or by artificial shading for more than one and one-half years.

2. A case of terminal and one of lateral bud mutation involving the same shape of leaf, and a change from broad to slender shape, was found in one variety, No. 6. In this variety also a bud mutation consisting in a change from green leaves spotted with yellow to leaves practically entirely green, was found.

3. An interesting case of a suspected bud mutation was found in which leaves tend to become a two-or three-part affair, the parts being connected with a tendril-like structure or bare midrib.

4. Non-heritable bud variations were found which were due probably to the varying conditions of nourishment, light, temperature and possibly other elements present in the environment.

ACKNOWLEDGEMENT

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ILLUSTRATIONS

PLATE I

Bud mutation in *Codiaeum Variegatum*
Fig. 1. Lateral bud mutation
Fig. 2. Terminal bud mutation.

A possible bud mutation of Variety No 6, Fig. *a* shows typical parent leaf. The rest are leaves of the plant constituting the bud variation.

TABLE I.—*Description of varieties of Codiaeum variegatum used in the study.*

Variety number	Leaf Characters.													Vigor of plant	Value of variety as ornamental	Remarks
	Apex	Margin	Texture.	Arrangement.	Form.	Color.		Succession of leaves on stem.	Length and greatest width of leaves	Branching	Abundance of leaves	Surface	Color of petiole	Nature	Appearance	
						Young leaf.	Old leaf		*cm.*							
1	acute	entire	leathery.	spiral .	lanceolate.	green	few dots	some portions are crowded	23 x 1 5	little amount	medium	shiny	green to purplish	rapid growing	fair	
2	acute	wavy	leathery	spiral	ovate	—	dark purple	regular . . .	8 5 x 3 0	branching, fair	medium	shiny	green to purplish	slow growing	good	
3	obtuse	lobed	leathery.	spiral	3 lobed obvate	green	green with yellow dots	regular	1 2 x 5 5	——	medium	shiny.	green to light purple	fairly rapid growing	not desirable	
4	obtuse some are mucronate.	entire	leathery	spiral	linear	green	lamina purple, midrib red	regular	29 x 1 0	——	profuse	shiny.	green to purple	fairly rapid growing.	good	Some leaves are parted forming two series of leaves like on a petiole
5	rounded some lobes acute	entire to cleft	leathery.	spiral	various forms	green with yellow spots .	green with yellow spots	regul: . .	9 0 x 3 0	——	profuse	shiny.	greenish	slow growing	superior .	Very great variation of leaves, some have extra outgrowth of the midrib and some are lobed
6	acute.	entire	leathery.	spiral	obovate	green with yellow dots	greenish yellow	regular	2 0 x 4 0	branching, fair	profuse	dull	greenish	fairly rapid growing	fair	Parent of variety No 15
7	acute	entire.	leathery	spiral	linear, lanceolate	dark green yellow midrib	light green with midrib and yellow spots	regular	35 x 3 0	heavy branching	medium	shiny	greenish	fairly rapid growing	fair	
8	acute	entire.	leathery	spiral	linear, lanceolate	dark green yellow midrib	see remarks	regular	35 x 3 0	heavy branching	medium	shiny	green to purplish	fast growing	good	The upper surface of old leaf is greenish with yellow dots and the midrib is somewhat red, lower surface purplish
9	acute	entire	leathery	spiral	linear, lanceolate	dark green	see remarks	regular	25 x 1 5	branching, fair	medium	shiny	purplish	quite slow growing	good	Upper surface dotted with yellow and red; lower surface purple, midrib red
10	acute	entire	leathery	spiral	elliptic	dark green with yellow dots	dark green with abundance of yellow spots	regular	26 5 x 6 0	branching, fair	medium	shiny	green to light purple.	husky growing	good	
11	acute	slightly-lobed	leathery	spiral	slightly obovate 3 lobed	dark green with yellow dots	see remarks	regular	20 0 x 7 0	little amount	medium .	shiny	whitish purple.	husky growing	very good	The leaves are from green to purplish
12	acute	entire	leathery	. spiral	linear	yellowish green	see remarks	regular .	35 0 x 3 0	little amount	medium	shiny	greenish purple	——	good	Greenish spotted with yellow with yellowish midrib
13	obtuse	entire	leathery.	spiral	oval	green	see remarks	regular	1 5 x 6 5	heavy branching	medium	shiny. .	greenish	slow growing	good	Some leaves are purplish green with yellow spots, some are almost yellowish purple
14	acute	cleft	leathery	spiral	3 lobed obovate	greenish.	green spotted with yellow	regular .	28 2 x 5 5	branching, fair	medium . .	shiny.	greenish	rapid growing	fair .	
15	mucronate	entire	leathery.	spiral	linear	greenish dot with yellow spots.	yellowish dotted with green .	regular . .	13 5 x 1 0	none	medium	shiny .	greenish	slow growing	good	Bud offspring of variety No 6
16	acuminate	entire	leathery	spiral	obovate	greenish.	green with few yellow dots. . .	regular .	10.0 x 3 0	——	medium .	shiny. .	greenish	rapid growing .	poor	Parent of variety No. 17
17	acute	entire.	leathery.	spiral .	linear .	greenish	greenish with few yellow dots . .	regular	13 x 1 0	——	medium . .	shiny.	greenish . .	slow growing. .	good	Bud offspring of variety No 16
18	mucronate	entire	leathery	spiral	linear	green	purple with greenish midrib	crowded at some portions . .	19.0 x 2 0	branching, fair .	medium . . .	shiny. .	greenish purple. . .	dwarf . .	superior . .	Some leaves are spirally curved and some are wavy while some are almost straight

Fig. 1. Lateral bud mutation.

Fig. 2. Terminal bud mutation.

PLATE I. BUD MUTATION IN CODIAEUM VARIEGATUM.

PLATE II.

REVIEW

Continuous renewal of nutrient solution for plants in water culture, TRELEASE, SAM. F., and LIVINGSTON, BURTON E. (*Science 55: 483-486. 1922.*)—As the science of plant physiology progresses from an imperical collection of observations of results to a systematic study of underlying causes, so new needs arise in technique. Take nutrition, for instance. Hitherto we have been studying the behavior of plants grown on solutions which we change at intervals in order to renew the supply of solutes which have been absorbed. Such a procedure, however, is open to serious objections. Suppose the solutions are changed every three days. What is happening between these changes? As soon as a change is made the plant commences its differential absorption of the different salts in solution and gradually their relative proportions are changed. Then on the third day the solution is renewed and the plant is suddenly subjected to a new series of conditions. It is a matter of common knowledge that sudden changes of conditions are more injurious than the conditions themselves may be. The more frequently, therefore, that the solution is changed in a nutrition experiment, the less violent the change of conditions.

It is to Trelease and Livingston that we are indebted for an ingenious piece of physiological plumbing whereby a constant flow of nutrient solution into the culture jar is ensured. A system of syphons is arranged between a large stock vessel and the bottom of the culture jar, and the rate of flow of the solution may be regulated by very simple adjustments. An exit tube at the top of the culture jar carries off excess solution. As a result the whole culture medium is constantly moving through the jar, and the nutrients supplied to the plant are practically uniform.

Reviewed by D. A. Herbert.

COLLEGE AND ALUMNI NOTES

His Excellency Leonard Wood, Governor-General of the Philippine Islands, inspected the Los Baños Colleges on July 19, and addressed the students from the porch of Administration Hall. The trend of his speech was the need of the Islands for trained agricultural producers in order that civilization, wealth, and good government may go forward.

Dr. Guy Potter Benton, the President of the University, formally opened the college of agriculture on June 13. He was accompanied by cadet commandant captain Davis.

Professor Baker resumed his position as Dean of the College of Agriculture on July 5, relieving Professor Roxas who had been acting since commencement.

Dean Baker was absent during the latter part of May and all of June, making an inspection trip through the Christian provinces of Northern Luzon, in company with and assisting Mr. Silverio Apostol, the Undersecretary of Agricultural and Natural Resources. The party went overland from Ilocos to the Cagayan Valley by the Claveria trail, and were some five weeks in the saddle. Many rich and beautiful regions were traversed, that are rarely visited by public officials, and much important data gathered. They returned through Nueva Vizcaya, over the Santa Fé trail to Cabanatuan.

Professor Hester was appointed to the position of Acting Registrar *vice* Dr. Mirasol, on March 15.

Professors Woodworth and Hester spent the latter part of April on a walking tour from Baguio, Mountain Province to Aparri, returning to Manila by boat.

Professor Emma S. Yule, left early in April on leave of absence for the United States. She expects to spend some time in Japan doing literary work.

Professor Higgins made two trips during the long recess, one to the southern islands and Mindanao, and one to Baguio. He collected valuable agronomical data especially in the vicinity of the Trinidad Valley.

Professors Koster and Ashcraft of the College of Veterinary Science spent several weeks in May at Baguio doing manuscript work.

Professor Lester Cook Neer left for the United States on June 25 due to continued ill-health.

Professor Schwartz was a Baguio visitor during the hot months.

Associate Professor Paul L. Pearl has been transferred from the College of Liberal Arts to the College of Agriculture where he is at present in charge of the Department of English.

Associate Professor Colin G. and Assistant Professor Doris B. Welles left on June 25 for the United States.

Assistant Professor Taylor took teacher's leave in Baguio during April and May.

Assistant Professor Mirasol has been appointed Dean of the Junior College of Liberal Arts in Cebu.

Dr. Leopoldo B. Uichanco returned from the United States and assumed duty as Assistant Professor of Entomology on May 16. He received the degrees of M. S. and Sc. D. from Harvard University, where he had been for several years a pensionado.

Dr. Francisco O. Santos returned from the United States and assumed duty as Assistant Professor of Chemistry on May 18. He had been for several years a pensionado, and received the degree of Ph. D. from Yale University. Dr. Santos's specialization was nutrition. He worked at Minnesota, Columbia and Cornell Universities. His Doctor's dissertation was "Studies in the nutrition of the Filipino".

Mr. Mariano B. Raymundo, B. S., has been appointed Assistant Professor of Agronomy and made Farm Superintendent. Mr. Raymundo established the work in Rural Economics several years ago, since which time he has been employed on Dr. Copeland's estate at Chico California. He has direct charge of the courses in farm management.

Dr. Francisco M. Fronda arrived in the Islands on April 21st and took up his position as Instructor in Animal Husbandry. He received the degrees of M. S. and Ph. D. from Cornell University where he went as a pensionado. He was elected a member of Sigma Xi. Dr. Fronda majored in poultry husbandry, and collaborated with Professor Maynard in the publication of some very important investigations in poultry husbandry.

Dr. Valente Villegas, accompanied by his wife and family, returned on June 29 from the United States, where he had been pursuing advanced work in the University of Illinois from which institution he received the degree of Doctor of Philosophy. His dissertation embodied valuable investigations in the field of poultry husbandry, which were conducted in collaboration with Professor Mitchell, and which are shortly to appear in published form.

Mr. José Velmonte, B. S. in Commerce, U. P., '22, has been appointed Instructor in Economics and assigned to the Department of Rural Economics. Mr. Velmonte was formerly in the Bureau of Commerce and Industry.

Mr. Hilarion Heneres has been appointed Instructor in Sugar Engineering to assist in conducting the Sugar Technology curriculum. Mr. Heneres is a graduate of the College of Engineering in the University of Illinois. He obtained valuable training in sugar work at the Audubon Sugar School of the University of Louisiana.

Mr. Bartolome C. Blanco, B.S., U. P., '22, has been appointed Instructor in Mathematics and assumed duty at the opening of the school.

The following graduate assistants have been appointed for the departments indicated: Roman P. Estioko (Plant Physiology), Juan Unite, Rafael M. Piguing, and Teofilo Novero (Agronomy); Severino Aquino (Entomology); Valeriano Sarmiento (Pathology) Felix Esguerra (Extension Service); Florencio M. Soliven (Chemistry).

The laboratory of Plant Physiology 1 has been moved to the Engineering laboratory and the space formerly occupied by it in Administration Hall has been made into class rooms thus relieving the entire east wing for the library.

Extensive repairs have been undertaken for the Engineering Laboratory and alterations effected in several other buildings.

The registration of students in the College of Agriculture on July 25 was 665 as against 622 for last year. A detailed analysis of the registration will be presented in the *Agriculturist* in the near future.

THE STRENGTH OF AN ANT

When a man runs at a speed of ten seconds to the hundred yards, people say it is wonderful. When a man lifts a load one and a half times his own weight, people call him a giant. Now read this and draw your own conclusion. It was a windy day, and while at dinner I noticed a grain of rice moving. Upon closer examination, I found a tiny ant carrying it along. Out of curiosity, I determined to find out the strength of the insect. I had the ant and the grain it carried weighed separately on an analytical balance with this result. Weight of the ant 0.000096 grams; weight of the rice grain 0.01017 grams.

The ant was strong enough to carry a load 105.94 times its own weight against a head wind of about 5 miles an hour. At this rate, if an ant was as large as a man of 50 kilograms weight, it would be able to carry a load of 5296.9 kilograms. Can any man carry a load of 106 times his own weight?

Contributed by Alexander Gordon.

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LIFE HISTORY AND HABITS OF SOME COMMON PHILIPPINE FLEA BEETLES[1]

By Feliciano Ramirez Reveche

WITH FOUR PLATES

While engaged in field work in plant pest control in the College of Agriculture vegetable gardens in the summer of 1919, the writer had occasion to observe some species of flea beetles which were causing considerable damage to eggplant (*Solanum melongena* L.); roselle, (*Hibiscus sabdariffa* L.); and okra, (*Abelmoschus esculentus* L.). On extending these observations to other parts of the College Campus, and to the vegetable gardens of Manila and Santa Cruz, Laguna, other plants, both cultivated and uncultivated, including ornamentals, were also found to be seriously damaged by the flea beetles.

Adult flea beetles feed on the epidermis of the stem, leaves, buds, and flowers of the host plants, puncturing the leaves and causing them to become yellow and drop, and, consequently, sometimes preventing the plants from bearing fruit. In severe cases the flea beetles bring about almost complete defoliation, so that the plants die for the lack of leaves to manufacture the food necessary for the plant life.

Despite their great importance in the country nothing has been done in the Philippines toward studying the younger stages of these little insects.

Chittenden (1) in *Insects injurious to vegetables* described the flea beetles as follows: "Flea beetles (*Halticini*)[2] constitute a sub-family of the leaf beetles. They are of elongate oval form and similar color, frequently striped like the cucumber beetle, and may be distinguished by their enormously developed hind thighs, which furnish them with powerful leaping ability. The most injurious forms are minute and dark-colored. Their habit of hopping from the plant upon which they are feeding has given them the common name of flea beetles or fleas, some species being known as "potato flea," "cabbage flea," etc., according to the plant infested. Many flea beetles are general feeders, and nearly all are subject to a periodicity, depending on factors with which we are little acquainted, but doubtless in large part traceable to atmospheric conditions, moist weather furnishing the best conditions for the development of the young or larvae, and dry weather being inimical to their increase, this hypothesis being based upon the knowledge that the larvae of many species are subterranean.

"Injury is frequently very severe on young plants and is due in the greatest measure to the ravages of the adult flea beetles which frequently appear in prodigious numbers

[1] Thesis presented for graduation from the College of Agriculture, No 144; Experiment Station contribution, No 91.

[2] For the purpose of this paper we are including in our discussion species of Halticinae and Eumolpinae

in cultivated fields and like a pestilence sweep everything before them, their depredations often necessitating the replanting of entire crops.

"The larvae of most flea beetles develop in weeds, a comparatively small proportion living on cultivated crops Knowledge of this fact is of value in indicating methods of control."

REVIEW OF IMPORTANT FOREIGN LITERATURE ON ALLIED SPECIES

No local or foreign literature on the biology and habits of Philippine flea beetles is at present available. The larval habits of local species are similar in many respects to those recorded for allied species in other countries. *Psylliodes* spp. studied here, all have boring larvae, and a species of *Psylliodes* is reported from Kiew (2) as boring in rape stems, whereas *P. punctulata* is reported by Quayle (3) as feeding on the roots of garden plants. *Phyllotreta* spp. are recorded as free living larvae almost without exception. (4), (5), (6), (7), (8). *Chaetocnemis* spp. are reported as borers in the larval stage (9), (10). Ramakrishma Ayyar (18) describes the damage by a species of *Longitarsus* whose larvae feed in the berries of *Piper nigrum* in India. Pupation in all species reported takes place in the soil. Authors reporting on various species agree in general as to the type of injury caused by the adult. They are especially harmful to vegetables (11), (12), (4), (13), (10), (8), (14) and to some of the field crops (15), (11), (16). The principal damage occasioned by the adults is the skeletonizing of the leaves. (15), (6), (9). Some records are found of adults injuring the stems of plants (8), an injury which is sometimes severe.

OBJECT OF PRESENT WORK

The object of the present study was to determine the life history and habits of some of the common Philippine flea beetles, with the possibility of finding, in these, hints as to effective methods of preventing their damage. Observations were made on several species, but since the writer has had to limit his work, only three species, *Psylliodes balyi* Jac., *Psylliodes splendida* Har., and *Nisotra gemella* Er. were studied in detail, the rest being only observed in the field for their occurrence, abundance, and habits.

TIME AND PLACE OF PRESENT WORK

This work was begun in 1919, and has been carried on from that time until the present writing, February 1922, at the College of Agriculture, Los Baños. During this time observations on occurrence, abundance, and habits were noted. Some of these observations were also made at the Manila gardens, Santa Cruz, Laguna, and the Lamao Experiment Station, Bataan, in 1920. The studies on the life histories of these beetles were made from June to December, 1921, in the Insectary of the Department of Entomology at the College of Agriculture.

DESCRIPTION OF METHODS AND EQUIPMENT

Several breeding methods were tried during the course of these experiments with varying degrees of success. For the purpose of aiding future investigators, the following methods which the writer has found successful are described.

For flea beetles with boring larvae, such as *Psylliodes balyi* Jac. and *Psylliodes splendida* Har., glass tubes of 1.5 millimeters diameter cut into lengths of from 15 to 20 millimeters were used. The ends were covered with cheese cloth of mesh fine enough to confine the larvae. Couples found in copula were placed in the tubes and supplied with fresh leaves each day. Before removal the leaves

were carefully examined for eggs. When eggs were found, they were transferred to individual petri dishes for further observation. The newly hatched larvae were transferred to individual growing plants which were enclosed with cheese cloth. Observations were made at various times each day.

For the flea beetles with free living larvae, such as *Nisotra gemella* Erichs., small tumblers were used half filled with moist friable earth. Copulating couples were confined by means of a cheese cloth top and fresh leaves were supplied each day. Examination was made daily for eggs, and when these were found, they were transferred to separate petri dishes. For life history studies, these petri dishes were half filled with moist soil and supplied with fresh food each day.

BIOLOGICAL STUDY OF *PSYLLIODES BALYI* (?) Jacoby[3]

1884—JACOBY, (17) Notes Leyd. Mus. VI. 30 (Sumatra)

1887—JACOBY, (18) Veth Midden-Sumatra Nat Hist. I. 158 (Sumatra)

1916—SCHULTZE, (19) Cat. Col Phil Is, Phil Jour Sci. XI D p. 93 (Luzon, Manila)

LIFE HISTORY

Couples of *Psylliodes balyi* Jac. were confined in separate cages, fed with fresh leaves each day, and kept under close observation in order that notes could be taken on the life history period. As soon as eggs were laid, they were transferred to individual cages and numbered. Considerable difficulty was encountered in obtaining complete life histories due to a high percentage of death in larval stage. The records obtained from these studies are tabulated in Table I.

TABLE I.—*Showing the incubation period for eggs of Psylliodes balyi Jac.*

Cage number.	Date of confinement.	Date laid.	Number laid.	Date of hatching.	Number hatched.	Per cent hatched.	Length of incubation period.
							days
1	8/26/21	9/2/21	16	9/8/21	10	62.5	6
1	8/26/21	9/7/21	3	9/11/21	3	100	4
2	8/26/21	8/28/21	10	9/2/21	7	70	5
2	8/26/21	8/30/21	2	9/6/21	2	100	6
2	8/26/21	8/31/21	8	9/5/21 9/6/21	3 5	37.5	5
3	8/26/21	8/30/21	16	9/7/21	3	50	7.5
3	8/26/21	8/30/21	4	9/4/21 9/5/21	1 1	25	5 8
4	8/27/21	8/28/21	15	9/8/21	11	80	6
4	8/27/21	8/30/21	7	8/4/21 9/6/21	3 9	43.8	5 6
5	8/27/21	8/31/21	19	9/7/21 9/8/21	2 4	78.9	7 8

[3] Charles Fuller Baker, Dean of the College of Agriculture, to whom the author is indebted for this determination, states that the determination of this insect is questionable.

TABLE II.—*Showing the life history of Psylliodes balyi Jac. under laboratory conditions.*

Egg Number.	Date laid	Date hatched.	Date in ground.	Date pupated	Date emerged.	Length of egg stage.	Length of larval stage.	Length of pupal stage.	Total.
						days	*days*	*days.*	*days.*
A_1	8/10/21	8/15/12	8/31/21	9/ 4/21	9/12/21	5	20	8	33
A_2	8/10/21	8/15/21	8/29/21	9/ 5/21	9/11/21	5	21*a*	6	32
A_3	8/10/21	8/15/21	8/31/21	9/10/21	9/15/21	5	26	5	36
A_4	8/10/21	8/17/21	9/ 3/21	9/11/21	9/17/21	7	25	6	38
A_5	8/13/21	8/19/21	Died	*a*	*a*	6	*a*	*a*	*a*
A_6	8/15/21	8/21/21	9/ 7/21	9/14/21	9/18/21	6	24	4	34
Average						5+	23+	5+	35

a In several cases the exact date was not definitely known owing to the change having taken place at night.

Egg.—The egg is pale yellow in color, spindle-shaped, broadest in the middle and tapering slightly and equally toward each end. The surface is roughened and marked with hexagonal reticulations. The average size from a series of measurements was 0.417 x 0.120 millimeter. When first laid the egg is shiny but just before hatching it becomes dull. The chorion is white.

In the cages, females laid their eggs on both faces of the leaves, principally along the midrib, although a few were deposited indiscriminately on the leaf surfaces.

Larva.—When newly hatched, the larva is a small legless grub, sparsely hairy, approximately 0.4 millimeter in length and 0.1 millimeter in width, shiny white and with a small light brown head about one half the width of the body. As it grows older it becomes pale yellow and finally light brown. Upon hatching the larva begins to feed immediately. The larvae which hatch from eggs laid on the midrib bore into it and down into the petiole and live on tissue of the stem. Those which hatch from eggs laid in cracks on the stem bore directly into the stem and feed there. Larvae were found feeding upon the stems, midribs, and petioles. Observations on the rate of feeding of the newly hatched larvae showed that these minute little animals can travel 5 centimeters in 5 minutes down the midrib of a leaf, making their tunnel as they feed.

Pupa.– The pupa resembles the adult both in size and general form. It is soft and white and finely pubescent. When the larvae are ready to pupate, they crawl out of the stem and fall to the ground. Pupation takes place in the soil. The writer has never found pupae within the plants but has had no difficulty in finding them in the soil around the plants in the laboratory.

Adult.—When the adult emerges, it hides in the soil for from one day to two days. At first it is white in color, changing later to brown and then to shiny black. Feeding commences when it becomes brown. Although the size varies in individuals, the males average considerably smaller than the females, sometimes only one half as large. Copulation takes place in from 7 to 10 days after emergence.

TABLE III.—*Showing the relative infestation of main stems, branches, and midribs or petioles*

Plants of *Solanum melongena* Linn examined for flea beetle attack, showing extent and location of attack *a*

No.	Larvae found in main stem.	Larvae found in branches	Larvae found in midrib and petioles
1	1	4	0
2	3	2	2
3	0	2 larvae 10 fresh eggs 2 chorions	0
4	3	5	0 2 eggs
5	0	7 2 eggs	1 egg
6	0	6 3 eggs	0
7	1	4	1 larva found in the petiole of the fruit.
8	2	3	0
Total	10	50	6

a No attempt was made in this examination to distinguish between the larvae of *P. balyi* Jac. and *P. splendida* Har.

In the laboratory breeding cages, the adults were found to like only very fresh leaves; when the leaves became five or six hours old they no longer fed upon them. The most satisfactory food for laboratory purposes was found to be the new leaves of the seedling eggplant.

During the experiment several beetles were inadvertently overlooked and received no food for from 3 to 5 days. These beetles lived and seemed to show no ill effects from their enforced starvation. Large collections of adults from the fields, confined without food in jars, died after one day, none living beyond three days.

HOST PLANTS

Wild plants.—No wild hosts of this beetle were observed but the writer suspects that it may feed upon Tarambulo (*Solanum cumingii* Dunal.), a rather common wild species of *Solanum* in the Philippines. This supposition is based on the fact that a spineless variety of *S. cumingii* which is cultivated on the College of Agriculture Campus, is a favored host plant of this pest.

Cultivated.—Both larvae and adults were found abundantly on *Solanum melongena* L., the former in midribs, petioles, and stems, the latter on the leaves and green tissue, or epidermis of the stems. Adults were also observed feeding on the leaves of an ornamental, *Solanum grandiflorum* P. and R., in September, 1919, when there were no eggplants growing in the fields of the College of Agriculture.

OCCURRENCE AND ABUNDANCE

Although this beetle breeds throughout the year it appears most abundantly from the latter part of December until July. During August and September the beetles are less numerous, but many couples in copula were observed in those months. In October and November they were quite scarce.

Observations made in December and January 1921 and 1922 on 100 eggplants at the College of Agriculture, showed an infestation of from 3 to 65 beetles per plant. These observations were made during bright sunshiny days. Notes on a garden of eggplants in the Barrio of Bayog, Los Baños, on December 30, 1921, show that *Psylliodes balyi* Jac. and *P. splendida* Har. were extremely abundant, feeding upon both surfaces of the leaves but seeming to prefer the upper. This garden was seriously damaged; most of the plants were defoliated and eight had succumbed to the attack of the beetles.

HABITS

The beetles are most active between the hours of 8 and 10 in the morning. At this time they feed upon the upper surface of the leaves and do most of their damage. During the hot part of the day many of them hide under the leaves and, although they feed then, they are much less active and the amount consumed is considerably less. Late in the afternoon they again become active. In the very early morning, when the leaves are covered with dew many of them may be found hiding on the lower surface of the leaves; they do not feed at this time.

Copulation has been observed principally in the morning and evening; sometimes at night. The process does not interfere with the feeding of the female, who continues as though the male was not there. Often as long as one hour is occupied in this process. It often happens that the female objects to the advances of the male, at which times she shoves him away with her hind legs.

The female, as a rule, lays her eggs in rows along the midribs of the upper surface of the leaves, sticking them flat on the leaf or in cracks in the stems and branches. Quite often they are found on the scars left by fallen leaves. Occasionally eggs may be found in masses or singly on almost any part of the plant.

The larvae live in the tissue of the stems, midribs, and petioles of both leaves and fruit. Their work seriously injures the plant, for most of the branches attacked die. An attacked plant can be recognized by the defoliation and dead tips of the branches. Those individuals which tunnel just under the bark of the stem produce characteristic black corrugations. In most cases, however, the larvae live and feed in the pith of the stem.

The adults attack all but the very thin young leaves, eating small irregular holes in the epidermis. Later, these holes dry up and the lower portion falls out leaving the leaf with a characteristic perforated appearance. These holes are the size of an adult beetle or slightly larger. Heavy infestations soon result in defoliation. When there are no leaves left on the plant, the adults eat the epidermis of the stem. In fields around the College of Agriculture the beetles are found on practically 100 per cent of the eggplants. Near the old boiler of the College is an eggplant plantation of some two years standing. The first year this plantation produced a good harvest, but in 1921 very little fruit was produced and many plants had no fruit at all. This was due principally to the attacks of *Psylliodes balyi* Jac. and *P. splendida* Har. which had killed the main stems of most of the plants In some cases the plants themselves have been killed.

BREEDING PLACES

The principal breeding place is the eggplant (*Solanum melongena* Linn.). In the absence of this plant the beetle probably breeds on *Solanum cumingii* Dunal. or *S. grandiflorum* P. and R. although larvae have not been observed on the latter.

METHODS OF DISTRIBUTION

While this beetle can fly, it more often travels from plant to plant by walking or jumping. Normally it walks from leaf to leaf and plant to plant, but if disturbéd it will jump. Seedlings in boxes or beds are favorite feeding places of this insect and are often quite seriously damaged. The adults are not easily disturbed from the seedlings and even the handling during transporting or transplanting does not free the plants from them. Undoubtedly this is an important factor in the distribution of these pests.

BIOLOGICAL STUDY OF *PSYLLIODES SPLENDIDA* (?) harold[4]

1877 —Harold, (20) Deutsche Ent. Zeits p. 364.
1916—Schultze, (19) Cat Col. Phil. Is., Phil Jour. Sci. XI D, p. 93.
(Luzon, Manila: Cebu, Toledo.)

LIFE HISTORY

In general, the life history and habits quite closely follow those of *P. balyi* Jac. In fact, during field observations, especially on the larvae, distinction between the habits of the two species was impossible. Table IV shows a series of breeding, indicating the average length of the various stages under laboratory conditions.

Table IV.—*Showing the life history of Psylliodes splendida Har. under laboratory condition.*

Egg number.	Date laid.	Date hatched.	Date pupated.	Date emerged	Length of egg stage.	Length of larval stage.	Length of pupal stage.	Total.
					days.	*days*	*days.*	*days.*
B_1	8/12/21			9/13/21				32
B_2	8/14/21	8/21/21	9/6/21	9/10/21	7	16	4	27
B_3	8/14/21	8/19/21	9/5/21	9/11/21	5	17	6	28
B_4	8/14/21	8/19/21	9/7/21	9/14/21	5	19	7	31
B_5	8/14/21	8/20/21	9/7/21	9/12/21	6	18	5	29
B_6	8/14/21	8/21/21	9/4/21	9/9/21	7	14	5	26
Average					6	17	5	28

Egg.—The eggs of *P. splendida* Har. are shiny pale yellowish in color, and oval in shape, sometimes slightly tapering toward one end. The surface is roughened and with hexagonal reticulations as in *P. balyi* Jac. Just before hatching

[4] Charles Fuller Baker to whom the author is indebted for this determination states that the determination of this insect is questionable.

the surface becomes dull. The chorion is white. The average size, from a series of measurements, is 0.472 millimeter x 0.239 millimeter. Couples were confined to determine the length of the egg stage. Table V shows the incubation period for 4 hatches of eggs.

TABLE V.—*Showing the incubation period of eggs of Psylliodes splendida Har.*

Cage number.	Date of confinement.	Date laid.	Number laid.	Date of hatching.	Number hatched.	Per cent hatched.	Length of incubation period.
							days
1	8/29/21	9/4/21	20	9/11/21	7	75	7
				9/12/21	8		8
2	8/29/21	9/1/21	3	9/8/21	3	60	7
		9/3/21	9	9/9/21	5		6
		9/4/21	8	9/10/21	4		6
3	8/29/21	9/4/21	10	9/11/21	3	40.9	7
		9/7/21	12	9/14/21	6		7
4	8/29/21	9/2/21	11	9/10/21	7	72.7	8
				9/12/21	1		10
Average incubation period							8+

Larva.—Except for size there is little difference between the larvae of *P. splendida* Har. and *P. balyi* Jac. The average size of the full grown larva of *P. splendida* Har. is 6.7 millimeters x 1.3 millimeters. Both species live in the tissue of the midribs, petioles, and stems.

Pupa.—As is the case with *P. balyi* Jac. the full grown larvae of *P. splendida* Har. leave their tunnels and drop to the ground to pupate. The pupae are white and resemble the adult in size and form.

Adult.—The imago remains in the ground for a day after emerging, hiding under particles of soil. Upon emergence it is white and soft but soon becomes darker, finally becoming metallic blue. Feeding starts soon after leaving the soil.

HOST PLANTS

Larvae and adults have the same host plants as *P. balyi* Jac.

OCCURRENCE AND ABUNDANCE

These insects appear at the same time and in company with *P. balyi* Jac., the latter, however, is far more abundant. Due to its slightly larger size, *P. splendida* Har. may do more damage individually, but *P. balyi* Jac. is decidedly the more numerous and therefore the more harmful species. In types of damage, methods of distribution, and breeding places, it closely resembles *P. balyi* Jac. Their relative abundance is shown in Table VI, from figures obtained by rearing the larvae found in eggplants in the field.

TABLE VI.—*Psylliodes balyi Jac. and Psylliodes splendida Har.*

No. of plants.	Date confined.	Date of emergence of adults from soil.	No. of adults of *Psylliodes balyi* Jac.	No. of adults of *Psylliodes splendida* Har.
1	7/15/21	8/13/21	2	0
		8/17/21	4	1
2	7/15/21	8/11/21	3	1
		8/15/21 (?)	2	2
		8/20/21	1	0
3	7/15/21	8/10/21	3	0
		8/16/21	1	3
		8/17/21	0	1
4	7/20/21	8/12/21	2	2
		8/16/21	3	1
5	7/20/21	8/20/21 (?)	4	2
		8/24/21	0	5
6	7/20/21	8/10/21	1	2
		8/12/21	2	0
		8/19/21	2	2
7	8/16/21	9/11/21	1	0
		9/12/21	2	2
8	8/16/21	9/11/21	2	0
9	8/21/21	9/13/21	1	0
		9/19/21	1	0
10	8/21/21	9/13/21	4a	0
			3a	
		9/15/21	1	1
Total. . .			45	26

a Dead

BIOLOGICAL STUDY OF *NISOTRA GEMELLA* Erichs[5]

1834—ERICHS., (21) Nov. Act. Leop. Car., 16, Suppl. 1. p 275 (Manila)
1887—JACOBY, (22) Veth Midden Sumatra Nat Hist, 1. p 153 (Sumatra)
1913—WEISE, (24) Phil. Jour. Sci. 8 D. p. 233—(Luzon).
1916—SCHULTZE, (23) Phil Jour. Sci., XI D. p. 92 (Luzon, Benguet, Baguio; Isabela, Panauan; Cagayan, San Luis; Rizal, Montalban Gorge; Palawan, Bacuit).

LIFE HISTORY

Egg.—The eggs are ovoid, the surface appearing smooth under the microscope, with fine white dotting. When first laid they are yellow in color, turning grayish before hatching. The average size from a series of measurements was 0.527 x 0.197 millimeter. After hatching, the chorion is white. The eggs are deposited in groups of from 5 to 11 around the base of a plant. The majority are deposited from 2 to 3 millimeters under the soil, although some are laid on or

[5] Determined by Charles Fuller Baker.

under the dead and decaying leaves below the plant. Sometimes these groups are laid in compact masses, other times are rather scattered. Table VII shows the average incubation period under laboratory conditions.

TABLE VII.—*Showing the incubation period for eggs of Nisotra gemella* Er.

Cage number.	Date of confinement.	Date laid.	Number laid.	Date of hatching.	Number hatched.	Per cent hatched.	Length of incubation period.
							days.
1	7/25/21	7/29/21	34	8/ 3 21	24	70	5
2	7/25/21	8/ 2/21	21	8/ 8/21	15	71	6
3	9/25/21	8/15/21	40	8/21/21	25	62	6
4	7/25/21	8/20/21	30	8/25/21	19	60	5
5	8/21/21	9/13/21	13	9/20/21	6	47	7
		9/17/21	10	9/23/21	4		6
6	8/21/21	9/13/21	11	9/20/21	3	85	7
		9/18/21	17	9/23/21	11		5
7	8/21/21	9/13/21	2	?	(?)	48	
		9/14/21	7	9/22/21	14		8
		9/17/21	28	9/23/21	3		6
8	8/21/21	9/13/21	1	9/22/21	1	54	9
		9/14/21	9	9/23/21	8		9
		9/19/21	12	9/25/21	3		6
9	8/30/21	9/ 9/21	53	9/10/21	13	71	1 (?)
				9/12/21	6		3
				9/13/21	12		4
				9/14/21	3		5
				9/15/21	2		6
				9/18/21	2		9
10	8/30/21	9/21/21	12	(?)*a*	7	57	
		9/25/21	47	(?)	33		
11	8/30/21	9/19 21	13	(?)	8	63	
		9/20/21	45	(?)	29		
12	9/10/21	9/10/21	6 p.m. 27	9/15/21	23		5
		9/12/21	31	9/16/21	7		4
Average			40 16		11 74	61 5	5.8

Larva.—The young larva is light brown in color, head the same color as the body. The last visible posterior segment is black. The body is covered with short fine hairs. As the larva grows older it becomes grayish in color. The full grown larva measures from 8 to 9 millimeters in length and 1 to 1.5 millimeters in width. The young larvae are very active, moving from place to place around the base of the plant on the surface of the soil, and hiding under the particles of soil or playing dead when disturbed. They do not commence feeding for from one to

one and a half hours after hatching, spending the time moving about on the surface of the soil, finally finding the stem of the plant and working their way down to the roots. A few do not go to the roots, but feed around the base of the plant, especially if the plant is young and tender. Larvae are often found clinging to the under surface of fallen green leaves. The usual food seems to be the small tender roots, although in the laboratory they would eat and do well on the green stem or fresh fruit of okra. When from 5 to 8 days old, the larvae feed throughout the day without stopping, later on they feed only occasionally, resting between meals. When almost mature the feeding seems to be confined to the early morning and late afternoon. Before pupating, the larvae form rounded or oval shaped cells in the soil, 1 to 1.5 millimeters below the surface. Larvae which have had an abundance of food and have moist soil to pupate in remain inactive in the pupal cell some time before pupating. On the other hand, larvae which have not had sufficient food and have dry soil in which to make the cell, pupate almost immediately.

Pupa.—The pupa resembles the adult insect in general form. The color is white, with black eyes. The body is covered with fine white hair, principally on the ventral surface. From 5 to 9 days are spent in this stage. (See Table VIII.)

TABLE VIII.—*Showing the life history of Nisotra gemella Er. under laboratory conditions.*

Egg number.	Date laid.	Date hatched.	Date of beginning of pupation.	Date pupated.	Date emerged.	Length of egg stage.	Length of larval stage	Length of pupal stage.	Total.
						days.	*days.*	*days*	*days.*
C_1	10/10/21	10/15/21	10/28/21	10/31/21	11/6/21	5	16	6	27
C_2	10/10/21	10/17/21	(?)	11/6/21	11/14/21	7	20	8	36
C_3	10/10/21	10/18/21	(?)	(?)	(?)	8	(?)	(?)	(?)
C_4	10/10/21	10/16/21	10/29/21	11/2/21	11/10/21	6	17	8	31
C_5	10/13/21	10/18/21	10/30/21	11/5/21	11/14/21	5	18	9	32
C_6	10/15/21	10/21/21	10/28/21	11/5/21	11/14/21	6	15	9	30
C_7	10/21/21	10/26/21	11/5/21	11/13/21	11/20/21	5	18	7	30
C_8	10/30/21	11/5/21	11/18/21	11/24/21	11/30/21	6	30	6	32
C_9	10/31/21	11/5/21	11/17/21	11/24/21	11/29/21	5	19	5	29
C_{10}	11/5/21	11/11/21	11/23/21	11/29/21	12/4/21	6	18	6	30
C_{11}	11/14/21	11/19/21	12/2/21	12/7/21	12/13/21	5	19	6	30
Average						5.8	18	7.3	30.6

Adult.—The young adult remains in the pupal chamber for 2 or 3 days after emerging. At first it is white. It hides among the soil particles for a day or so without feeding, the elytra becoming light brown on the second day, later blue-black.

Egg laying.—The female starts laying eggs from 18 to 20 days after emergence. The average number of eggs from 12 females was found to be 40+(See Table VII).

Longevity.—Adults kept in a container without food died in from 7 to 10 days.

Food.—In the laboratory the adults did equally well on the young leaves of Calot-calotan (*Triumfetta bartramia* L. and *T. semitriloba* Jacq.) Calot-calotan (*Urena lobata* L.), Okra and Roselle.

Habits.—When the adults are disturbed, they stop feeding and remain motionless. If greatly disturbed they either fall to the ground or hop to another leaf. The adults feed in the early morning and late afternoon. Copulation takes place either day or night. If the couple are in copula during the feeding hours the female proceeds with her feeding apparently undisturbed.

HOST PLANTS

Wild plants.—

1. *Abelmoschus moschatus* Medik. (Castuli, Capuli).
2. *Triumfetta bartramia* L. (Calot-calotan).
3. *Triumfetta semitriloba* Jacq. (Calot-calotan).
4. *Urena lobata* L. (Calot-calotan).

Cultivated plants.—

1. *Abelmoschus esculentus* (L.) Moench. (Okra, Gumbo).
2. *Hibiscus sabdariffa* L. (Roselle).
3. *Hibiscus rosa-sinensis* L. (Gomamela).
4. *Malvaviscus* sp. (C. of A. 1152).

OCCURRENCE AND ABUNDANCE

From June to September, 1921, there was no okra nor roselle growing on the College Campus. During that time material for study was easily obtained from calot-calotan. This plant is very abundant in the waste places around the Campus. In a field in Coconut Grove near the entrance to College Campus practically every plant was attacked, the beetles being most numerous on the younger plants. When okra and roselle were planted in the latter part of September, 1921, the adults were observed feeding on both, but seeming to prefer the latter. They were found in abundance on castuli throughout the year. While specimens may be found with ease at any season, they are particularly abundant during December and January.

NATURE AND EXTENT OF DAMAGE

The adults feed almost exclusively on the under surface of the leaves, eating small holes entirely through the leaf. When numerous on a leaf these holes may practically skeletonize it. Some preference is shown for the newer and younger leaves. Although the extent of damage would appear serious, especially on roselle, the growth in height is not retarded. The body of the attacked plant, however, is weak. Unless practically skeletonized, the leaves turn yellow after several days and when the plants are mature, the older, perforated leaves fall. At this time the beetles leave the leaves and start feeding on the epidermis of the stem.

Most damage is done to roselle, the introduced Hawaiian varieties of *Hibiscus rosa-sinensis* L., and the wild host plants. Okra is only slightly attacked, and the writer has never observed them on the native gomamela.

BREEDING PLACES

In the absence of its cultivated hosts this beetle can and does exist on its abundant wild hosts. In fact, excepting roselle, the wild hosts seem to be preferred.

METHODS OF DISTRIBUTION

Nisotra gemella Er. is widely distributed throughout the archipelago. Aside from its own ability to fly and hop, man is probably responsible for transporting the pest on parts of the wild or cultivated fiber plants which are its hosts. The larvae are carried on the earth around the roots of its host plants when entire plants are shipped.

MISCELLANEOUS NOTES ON OTHER SPECIES OF FLEA BEETLES

LUPEROMORPHA PROLIXA gr[6]

This beetle was observed feeding upon the flowers, particularly the petals, of nearly all the flowering plants of the College Campus. On the gomamela and alfalfa flowers the irregular holes perforate the petals but on rosal only the epidermis is eaten. This beetle is found throughout the year, more abundant, perhaps, in the months of August, September, and October. In going from place to place it uses its wings more often than the species previously discussed, some of the flights measuring in direct distances about 25 meters. The eggs of this species are laid in the soil.

LONGITARSUS MANILENSIS weise[7]

The wild host plant of this insect around the campus of the College of Agriculture is *Crotalaria*. This plant is also cultivated here as a cover crop. In July, 1921, the beetle was found occasionally, perforating the leaves of sitao (*Vigna sesquipedalis* L.) in the trial beds of the College. It is an abundant species throughout the year and does considerable damage to *Crotalaria*, feeding on the lower surface of the leaves. A light touch does not disturb it, but, if repeatedly interfered with, it jumps. The writer has never observed this species flying. In the hot part of the day and especially when the wind is blowing, the beetles are very restless moving from place to place, but not feeding. In the rain they hide beneath the leaves. The feeding hours are from 8 until 10 in the morning and from about 2:30 to 6 in the afternoon.

The eggs greatly resemble those of *Psylliodes balyi* Jac. The average size is 0.367 millimeter x 0.243 millimeter. They are laid in the soil. The larvae feed upon the roots of *Crotalaria*.

NISOTRA sp[8]

A common flea beetle on gomamela and *Malvaviscus* sp., the adults feeding upon the buds, leaves and flowers. It is usually found on the lower surface of the leaves although occasionally it may be found on both surfaces. The damage is from the perforation of the leaves.

PAGRIA GRAPHICA weise[9]

These beetles are abundant at the College in the months of July and August. Some may be seen almost any time of year but during January and February

[6] Determined by Charles Fuller Baker.

[7] Determined by Charles Fuller Baker.

[8] Specimens are in the collection of the Department of Entomology, College of Agriculture, Los Baños, No. 00119 F. Determined by Charles Fuller Baker.

[9] Determined by Charles Fulle Baker

they become rather scarce. They are very destructive to sitao (*Vigna sesquipedalis* L.); Pa-ayap (*Vigna sinensis* L.); Patani (*Phaseolus lunatus* L) and batao (*Dolichos lablab* L.). They may also be found on wild beans and abundant on *Desmodium tortuosum* D. C.[10], a plant used for a cover in the Southern United States and evidently an escape here, according to Dr. Merrill. These beetles make small holes in the epidermis of the lower surface of the leaves. The damage, however, is sometimes severe.

LONGITARSUS sp.[11]

This tiny yellow beetle is plentiful during the months of July and August on *Bridelia stipularis* (Linn.) Blume,[12] but has not been observed during the rest of the year. It makes small holes in the leaves and sometimes completely skeletonizes them. The oval white eggs are deposited in the soil.

PSYLLIODES sp[13]

During the months of July, August, September and October this beetle is abundant on *Amaranthus*. The adult feeds upon the leaves.

HESPERIA sp.[14]

Specimens of this beetle were found flying, and also on the flowers of gumamela on Faculty Hill above the College. Small irregular holes are made in the petals. It was very plentiful in September, October, and November, 1921. The small elongate white eggs are laid in the soil. The average size is 0.315 millimeter x 0.190 millimeter. Slight damage is occasioned by this species.

PHYLLOTRETA sp.[15]

Considerable injury from this species was observed in gardens in Santa Cruz and Los Baños, Laguna, and in the Manila garden near Paco Station, on mustard, pechay and radish. On radish, however, the damage was less than on the other two. The damage consisted in numerous small perforations of the leaves. They were most abundant during October and November in 1920 and January and February 1921. At times the damage from this beetle is most serious.

CHAETOCNEMA sp.[16]

In September, 1921, this species was found in large numbers on young upland rice, leaving the rice when the grain became mature. The upper surface of the leaf was eaten, parallel to the veins, the leaf later turning yellow and drying up. Often the adult encloses itself in the newly unfurled leaves. It has also been observed on lemon grass (*Andropogon citratus* D.C.). Guinea grass (*Panicum maximum* Jac.) and corn (*Zea mays* L.)

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[10] Determined by E D Merrill, Director, Bureau of Science, Manila.

[11] Specimens are in the collection of the Department of Entomology, College of Agriculture, Los Baños, No. 00119 H. Determined by Charles Fuller Baker

[12] Determined by E D Merrill, Director, Bureau of Science, Manila.

[13] Specimens are in the collection of the Department of Entomology, College of Agriculture, Los Baños, No. 00119 I. Determined by Charles Fuller Baker.

[14] Specimens are in the collection of the Department of Entomology, College of Agriculture, Los Baños, No 00119 J Determined by Charles Fuller Baker.

[15] Specimens are in the collection of the Department of Entomology, College of Agriculture, Los Baños, No 00119 K Determined by Charles Fuller Baker

[16] Specimens are in the collection of the Department of Entomology College of Agriculture, Los Baños, No 00119 L Determined by Charles Fuller Baker.

PHYLLOTRETA sp.[17]

The writer has observed this beetle in considerable numbers during January, February, and March, in the Manila gardens near Paco Station. During the rainy season it becomes quite scarce. It attacks mustard seriously and pechay slightly, skeletonizing the leaves, often killing mustard plants.

HOST PLANTS OF FLEA BEETLES

PSYLLIODES BALYI Jac. (Halticinae.)

CROP PLANTS
Solanum melongena Linn. (Eggplant)
Solanum cumingii Dunal (Tarambulo)
ORNAMENTAL PLANTS
Solanum grandiflorum P. & R.

PSYLLIODES SPLENDIDA Har (Halticinae.)

CROP PLANTS
Solanum melongena Linn.(Eggplant)
Solanum cumingii Dunal (Tarambulo)
ORNAMENTAL PLANTS
Solanum grandiflorum P. & R.

NISOTRA GEMELLA Er (Halticinae.)

CROP PLANTS
Hibiscus sabdariffa L. (Roselle)
Abelomoschus esculentus (L) Moench, (Okra, Gumbo)
ORNAMENTAL PLANTS
Hibiscus rosa-sinensis L. (Gomamela)
Malvaviscus sp.
WILD PLANTS
Abelmoschus moschatus Medik (Castuli, Calupi)
Urena lobata L. (Calot-calotan)
Triumfetta semitriloba Jacq. (Calot-calotan)
Triumfetta bartramia L. (Calot-calotan)

LUPEROMORPHA PROLIXA Er. (Halticinae.)

CROP PLANTS
Medicago sativa L. (Alfalfa)
Arachis hypogaea L. (Peanut)
Zea mays L. (Corn, Maize).
ORNAMENTAL PLANTS
Gardenia florida L. (Rosal)
Hibiscus rosa-sinensis L. (Gomamela)

LONGITARSUS MANILENSIS Weise. (Halticinae.)

CROP PLANTS
Vigna sinensis L. (Pa-ayap)
Crotalaria incana L[18] (Latuc-latucan, Patoc-patocan)

[17] Specimens are in the collection of the Department of Entomology, College of Agriculture, Los Baños, No. 00119 O. Determined by Charles Fuller Baker.

[18] Sometimes used as cover crop at the College of Agriculture

NISOTRA sp (Halticinae)

ORNAMENTAL PLANTS

Hibiscus rosa-sinensis L.

Malvaviscus sp.

PAGRIA GRAPHICA Ws. (Eumolpinae.)

CROP PLANTS

Phaseolus lunatus L. (Patani)

Dolichos lablab L. (Batao)

Vigna sesquipedalis L. (Sitao)

Vigna sinensis L. (Pa-ayap)

WILD PLANTS

Desmodium tortuosum D. C.

LONGITARSUS ? sp. (Halticinae)

WILD PLANTS

Bridelia stipularis (Linn) Blume.

PSYLLIODES sp. (Halticinae)

WILD PLANTS

Amaranthus sp.

HESPERA sp

CROP PLANTS

Zea mays L. (Corn)

ORNAMENTAL PLANTS

Hibiscus rosa-sinensis L. (Gomamela)

PHYLLOTRETA sp. (Halticinae)

CROP PLANTS

Brassica sp. (Pechay, mustard)

Raphanus sativus L. (Radish)

CHAETOCNEMA sp. (Halticinae)

CROP PLANTS

Oryza sativa L. (Rice)

Zea mays L. (Corn)

Hibiscus sabdariffa L. (Roselle)

ORNAMENTAL PLANTS

Andropogon citratus D. C. (Tanglad, lemon grass)

PHYLLOTRETA sp. (Halticinae).

CROP PLANTS

Brassica spp. (Mustard, pechay)

SPRAY EXPERIMENTS FOR THE CONTROL OF FLEA BEETLES

Spray experiments were first undertaken in April, 1919, on the small egg-plant plots of the College of Agriculture vegetable garden. The plants were sprayed with a solution of paris green (formula No. 1) each week for a month. Observations on its effects were carefully noted every day. Fairly good results were obtained but not sufficient to recommend the spray for that purpose.

In July, a mixture of paris green and Bordeaux(formula No. 2) was tried. The spraying was done as before. Daily observations showed a gradual decrease in the numbers until the plants were practically free of the pests. The same formula was then used by an agronomy class on plots of roselle, in a planting of 16 plots. As a result of the spraying, these treated plants developed normally and were almost entirely free from flea beetle infestation. The unsprayed plots showed various degrees of infestation and damage from medium to very severe. The difference was very striking. No burning was observed.

The spray solutions were made from the Standard Formulae of the Department of Entomology.

Formula 1.——

Paris green	120 grams
Air slaked lime	600 grams
Water	200 liters.

Make a paste with the paris green, add the lime, then strain through a sieve into a tank containing the requisite amount of water. Keep well agitated while spraying.

Formula 2.——

Copper sulfate	1.8 kilograms
Stone lime	1.8 kilograms
Water	190 liters

Dissolve the copper sulfate in hot water. Add sufficient water to make 95 liters. Slake the lime and add sufficient water to make 95 liters. Pour both solutions into a third container at the same time. Agitate vigorously and strain.

To each 200 liters of Bordeaux solution add 120 grams of paris green. Keep well agitated while spraying.

SUMMARY AND CONCLUSIONS

Thirteen species of flea beetles were encountered during the course of this work, which are included under six different genera. The habits of three of these, *Psylliodes balyi* Jacq. *Psylliodes splendida* Har. and *Nisotra gemella* Er., which are rather common on the College Farm, were studied in detail. The rest, which are more or less numerous depending on the locality and season of the year, were studied in the field.

Two species studied were observed to lay their eggs in the cracks of the stems and branches, the other species usually laid their eggs in the ground or under dead leaves. On the whole the period of egg incubation lasted from 5-10 days depending on the species. Good percentages of hatch were obtained in the laboratory.

The larvae of the different species were observed to fall under two classes as regards their habits. One class, represented by *Psylliodes* spp., bores into the stem, often-times going into the pith and spending the entire larval stage inside

the stem. The other class, represented by *Nisotra gemella* Er., digs into the ground and feeds on the tissues of the root. The larval stage is very destructive with most of the species. The larval stage lasts from 16 to 27 days, although in the case of *Nisotra* it is generally shorter.

Pupation of all the different species takes place in the soil. It lasts from 4 to 8 days depending on the species.

The adult stage is the most destructive stage with some species. The life cycle is completed in from 26 to 45 days. Some species have very short life cycles while other have long ones, lasting 45 days. In the adult stage the insects are active. Adults feed on the leaves, flowers, buds, and stems. The most active periods are generally from 9 to 10 in the morning and late in the afternoon.

The larvae and the adults usually have the same hosts. Nearly all kinds of cultivated plants were found attacked by one or more species, although some species were confined to certain particular classes of pla ts. *Psylliodes* spp. are generally found on solanaceous plants and *Nisotra* on *Malvacae* both wild and cultivated. In some cases, as with *Luperomorpha prolixa* Er., several classes of cultivated plants are attacked. Out of the thirteen species studied, six were actually found on wild plants, and the rest most probably may tide over certain periods on the wild plants if conditions necessitate.

Experiments on starvation show that most of the beetles die the first day and the rest die within three days in case of *Psylliodes* and in 10 days in the case of *Nisotra*. Punctured leaves and flowers, holes in the epidermis of the stems or the fruits, yellowing and falling of large numbers of the leaves, and in some cases defoliations, are signs of the attack of adults. Gradual drying of attacked leaves and tips are signs of larval attack.

Field conditions showed that in general the beetles are in great abundance in the months of December and January. Occasionally they are found during the months from March to August but rarely from September to November. *Nisotra gemella* Er. may appear in more or less abundance throughout the year.

Their habits in the larval, as well as in the adult stage, facilitate their being carried from place to place with hosts.

No preventive measures of control have been carried out, but the biological facts and habits of these insects point to the feasibility of such methods. With these facts about the particular species, rotation of crops may be effective.

Spraying was tried as a means of control. Experiments showed that spraying with paris green is not very effective. A mixture of paris green and Bordeaux mixture was found to be effective in controlling the insect in the field and to insure the normal growth of the crops attacked.

RECOMMENDATION

In fighting these insects, efforts should be directed toward the adult stage. In controlling the adult, spraying and rotation of crops to suit particular species should be practiced.

Weeds and wild plants serving as hosts should be destroyed.

Spraying should be done early in the morning or before late in the afternoon to be most effective.

As to quarantine measures, the soil going with plants should be examined for eggs, larvae, and pupae, and the plant for eggs, and signs of attack by either larva or adult. Infected plants, discovered in transit, should be destroyed.

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ILLUSTRATIONS

PLATE I

Fig. 1.—Adult *P balyi* Jacq. x 25.
2.—Egg x 50.
3.—Larva x 20.
4.—Adult *P. splendida* Har. x 15
5.—Egg x 50
6.—Larva x 20

PLATE II.

Fig. 1.—Adult *N. gemella* Er. x 20
2.—Egg x 50
3.—Larva x 20
4.—Pupa x 20

PLATE III

Eggplant attacked by *P balyi* Jacq. and *P. splendida* Har. Note the defoliated branches and the characteristics of the attacks on the leaves.

PLATE IV.

Roselle plant attacked by *N. gemella* Er. Note the defoliated branches and the adult beetles on the stem feeding on the tissues of the epidermis

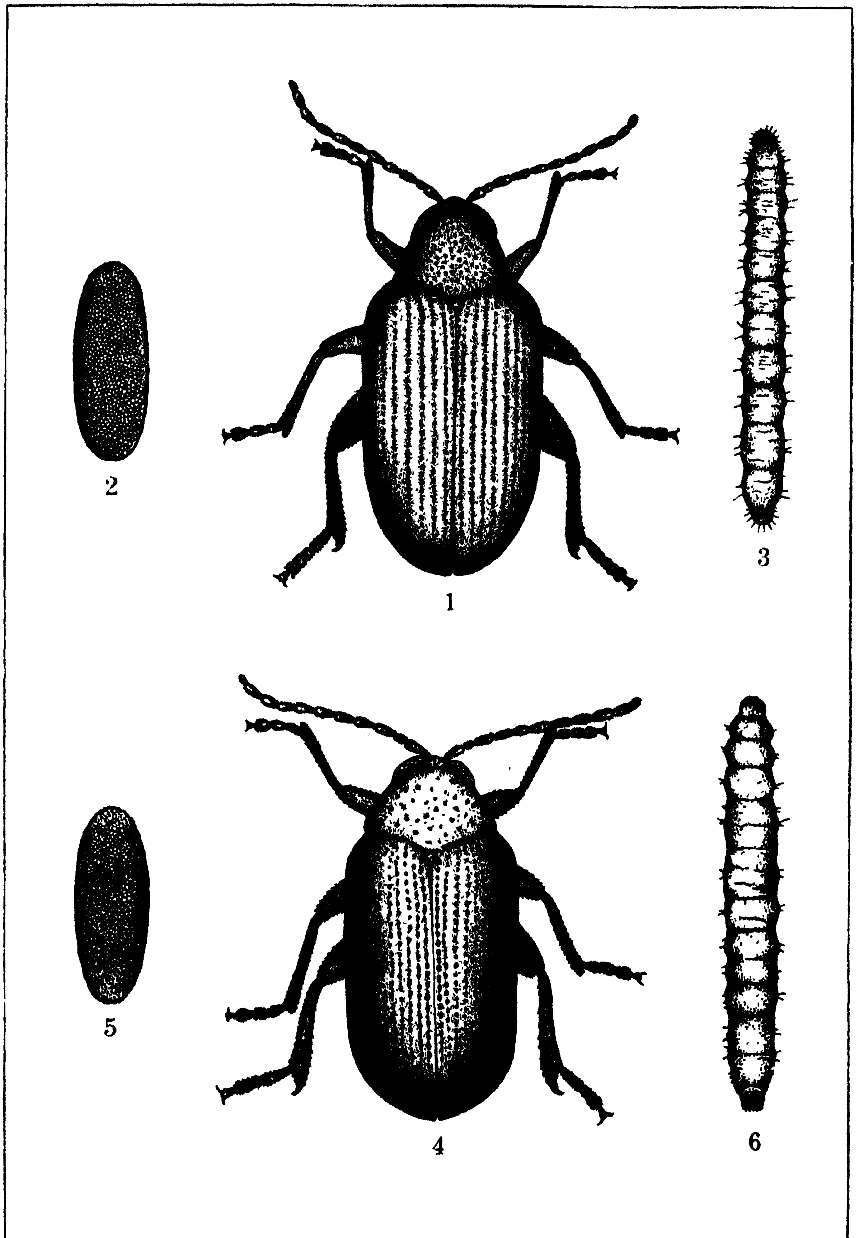

PLATE I.

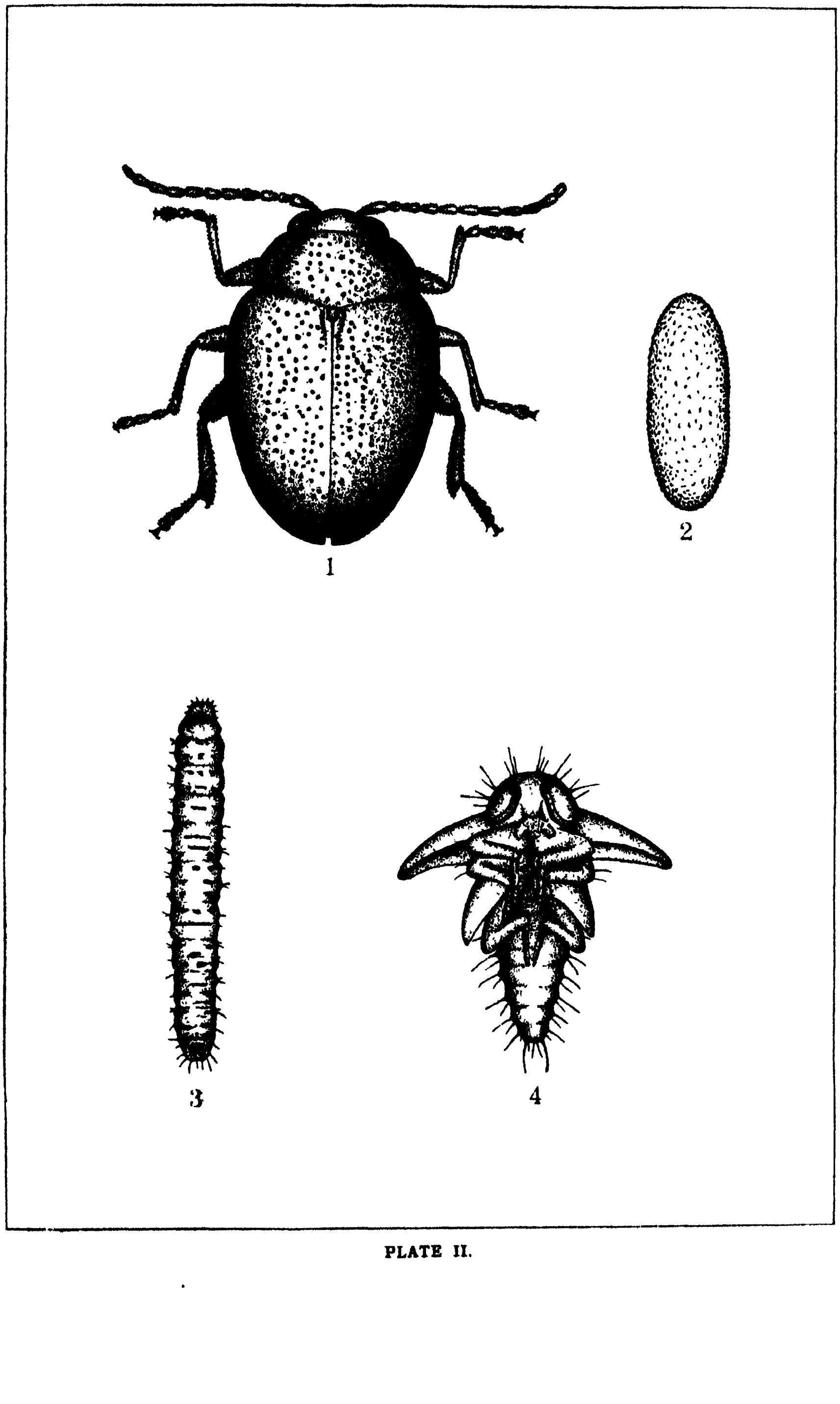

PLATE II.

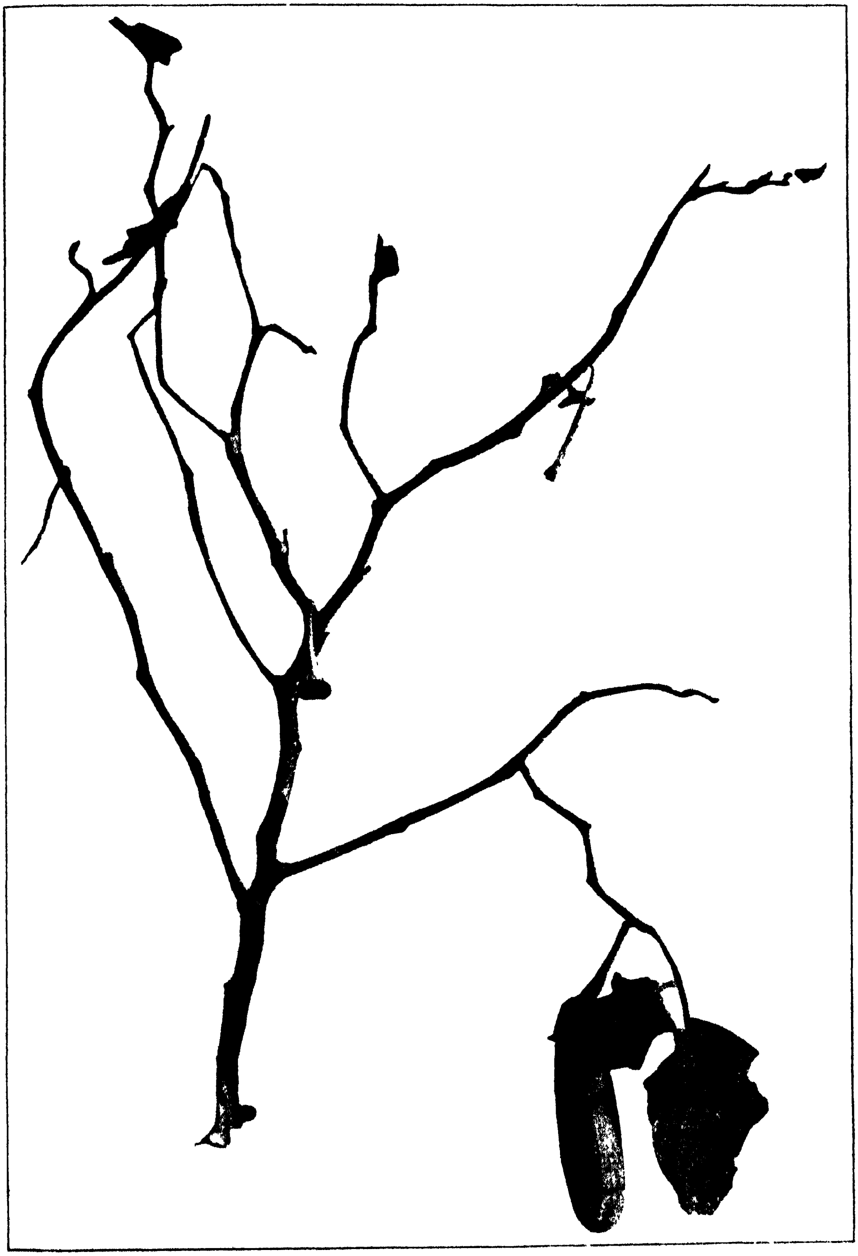

PLATE III.

PLATE IV.

A HOST INDEX OF INSECTS INJURIOUS TO PHILIPPINE CROPS: III[1]

By H. E. Woodworth

Of the Department of Entomology

In this supplementary index of economic insects of the Philippines are listed a number of the less commonly met lepidopterous pests, which have been bred from larvae found attacking the plants under which they are listed. A few of these, however, deserve more than passing notice, and one in particular, *Margaronia caesalis* Walk., a pest of *Artocarpus communis* Forst., will receive individual discussion in a separate paper.

Earias fabia Stoll., a beautiful little noctuid, has been observed as a rather serious pest of Okra pods. It is a rather common Indian and Javan pest of malvaceous plants. Dammerman[2] calls it the "Englesch-Indische" cotton bollworm. It enters the pod either at the tip or side and feeds upon the seeds. So far, it has not been recorded from cotton in the Philippines, but undoubtedly it will be found attacking this plant also, as is its habit in other countries.

A most interesting pyralid borer (*Alophia* sp.) has been bred from the fruits of the Chico (*Achras sapota* Linn.). Mr. William Schaus of the United States National Museum, who has furnished me many of the lepidoptera determinations, states that it is an undescribed species. Although it is not abundant, it seems odd that such a conspicuous pest of a commercial fruit should remain unknown to science until this time. The frass-covered holes in the fruit and the "worm eaten" inside, render the fruit uneatable and unmarketable.

During the months of November, December, January, February and March a large psychid (*Clania fuscescens* Snell) was abundant on several hosts on the college campus. The "bag" is slender and conical, grayish white with several variable irregular black spots. It is one of the largest of the bag worms of this region and sometimes occurs as a pest of Citrus, Bignay (*Antidesma bunius* (L.) Spreng.) and others.

The arctiid, *Maenas maculifera* Walk. has occurred from time to time as a serious defoliator of Ilang-ilang (*Canangium odoratum* (Lam.) Baill.) and Mango (*Mangifera indica* Linn.). The larvae spin webs over the trunk and in the crotches of the trees and migrate to the leaves for feeding. Several trees on the college campus have been practically defoliated by this pest during the last year. The attack was easily controlled by burning the webs and spraying the foliage with lead arsenate.

Orgyia postica Walk. has been found attacking Citrus and Mango in addition to its previously reported hosts[3]. The variety of plants attacked by this pest and the seriousness of some of the infestations, place it with *Prodenia litura* Fabr. and *Chloridea obsoleta* Fabr. as a general farm pest. It has a wide distribution, extending from India through the Indo-malayan sub-region to Formosa, and has been recorded as an important pest in several of these countries.

[1] Experiment Station contribution, No. 92.
[2] Dammerman, K. W. Landbouwdierkunde van Oost-Indie, pp 368, Amsterdam, 1919.
[3] Woodworth, H. E. A Host Index of Insects Injurious to Philippine crops. Philippine Agriculturist 10: 9-35, 321-329. 1921, 1922.

Two small leaf rolling moths have been bred from cotton leaves, and are added to the numerous cotton insects of the Philippines. *Sylepta derogata* Fabr., a leaf roller recorded from India and Java, is found here in large numbers and may be considered as a major pest of cotton as grown at the College of Agriculture. Three interesting parasites have been bred from the larvae, ***Chalcis obscurata*** Walk., *Elasmus philippinensis* Ashm. and *Pleurotropis* sp.[4] *C. obscurata* Walk. was also bred from the larvae of *Margaronia caesalis* Walk. *Homona menciana* Walk., a small tortricid, is also found attacking cotton here, but to a less extent than *S. derogata* Fabr.

Another cane borer has been added to the Philippine list, *Sesamia uniformis* Dudgeon. This borer was bred from specimens taken at San José, Mindoro. The larvae were observed burrowing in the cane at the "points" or buds and it might properly be called a "point borer". This species has been recorded from India as an important cane pest. While not found in large numbers at San José, further investigation may prove it to be a factor in sugar production here. Several specimens have since been collected at Pansol, Laguna.

Investigations carried on by the Department of Entomology during the year have brought out much valuable information concerning the life histories and habits of certain Philippine flea beetles. Several of the interesting and important host records of flea beetles included in this list are the result of these investigations, a report of which is being published in this journal.[5]

HOST INDEX

ABELMOSCHUS ESCULENTUS (L.) Moench. (*Hibiscus esculentus* L.) (Okra, Gumbo.)

LEPIDOPTERA (Heterocera)

NOCTUIDAE

Earias fabia Stoll.

ACHRAS SAPOTA Linn. (Chico)

LEPIDOPTERA (Heterocera)

PYRALIDAE

Alophia sp.

PSYCHIDAE

Clania fuscescens Snell.

ANONA SPP. (Guanabanos, Soursop, Anonas, Custard Apple, Ates, Sugar Apple.)

DIPTERA

TRYPETIDAE

Dacus cucurbitae Coq.
Dacus ferrugineus Fabr.

ANTIDESMA BUNIUS (L.) Spreng. (Bignay)

[4] Determined by A. B Gahan, U. S. Department of Agriculture, Washington, D. C.

[5] Reveche, Feliciano. Life history and habits of some common Philippine flea beetles. Philippine Agriculturist 11:2, 29-48. 1922.

LEPIDOPTERA (Heterocera)

PSYCHIDAE

Clania fuscescens Snell.

ARACHIS HYPOGAEA Linn. (Mani, Peanut.)

COLEOPTERA

CHRYSOMELIDAE

Lupermorpha prolixa Erichs

ARTOCARPUS COMMUNIS Forst. (Colo, Pacac, Bread fruit)

LEPIDOPTERA (Heterocera)

PYRALIDAE

Margaronia caesalis Walk.

BRASSICA SPP. (Cabbage, Mustard, Turnip, Pechay.)

COLEOPTERA

CHRYSOMELIDAE

Phyllotreta spp.

CANANGIUM ODORATUM (Lam., Baill (*Cananga odorata* Hk f & Th) (Ilang-ilang)

LEPIDOPTERA (Heterocera)

ARCTIIDAE

Maenas maculifera Walk.

CANAVALIA SPP. (*C. ensiformis* (L) DC ; *C. gladiata* (Jacq.) DC.) (Haba)

LEPIDOPTERA (Heterocera)

PYRALIDAE

Maruca testulalis Geyer.

THYRIDIDAE

Striglina scitaria Walk.

CITRULLUS VULGARIS (L.) Schrad. (Sandia, Watermelon.)

DIPTERA

TRYPETIDAE

Dacus caudatus Fabr.

CITRUS SPP. (Dayap, Limon, Luchan, Suha, Pomelo, Narangita, Sitones, Calamondin, Calamansi.)

LEPIDOPTERA (Heterocera)

LYMANTRIIDAE

Euproctis flavata Cram.

Orgyia postica Walk.

PSYCHIDAE

Clania fuscescens Snell.

HEMIPTERA (Homoptera)

COCCIDAE

Chrysomphalus dictyospermi Morg.
Lepidosaphes becki Newm.
Lepidosaphes gloveri Pack.
Parlatoria brasiliensis Morr.
Parlatoria pergandii Comst.
Parlatoria proteus Curt.
Pseudaonidia trilobitiformis Green.

COLOCASIA ESCULENTUM (L.) Schott. (*C. antiquorum* Schott.) (Gabi, Taro.)

HEMIPTERA (Homoptera)

COCCIDAE

Pseudococcus virgatus Ckll.

CROTALARIA SPP.

COLEOPTERA

CHRYSOMELIDAE

Longitarsis manilensis Weise.

DOLICHOS LABLAB Linn (Lablab Bean.)

COLEOPTERA

CHRYSOMELIDAE

Pagria graphica Weise.

GOSSYPIUM SPP. (Bulac, Algodon, Cotton.)

LEPIDOPTERA (Heterocera)

PYRALIDAE

Sylepta derogata Fabr.

TORTRICIDAE

Homona menciana Walk.

HIBISCUS SABDARIFFA Linn. (Roselle.)

COLEOPTERA

CHRYSOMELIDAE

Chaetocnema sp.
Nisotra gemella Erichs.

IPOMOEA BATATAS (L.) Poir. (Camote, Sweet Potato.)

COLEOPTERA

CHRYSOMELIDAE

Prionispa sp.

MANGIFERA INDICA Linn. (Manga, Mango.)

LEPIDOPTERA (Heterocera)

ARCTIIDAE

Maenas maculifera Walk.

LYMANTRIIDAE

Orgyia postica Walk.

NOCTUIDAE

Chlumetia transversa Walk.

PYRALIDAE

Macalla sp.

Orthaga melanoperalis Hamps.

MUSA TEXTILIS Nee (Abaca.)

LEPIDOPTERA (Heterocera)

NOCTUIDAE

Phytometra chalcites Esp.

ORYZA SATIVA Linn. (Palay, Arroz, Rice.)

LEPIDOPTERA (Heterocera)

PYRALIDAE

Marasmia venilialis Walk.

COLEOPTERA

CHRYSOMELIDAE

Chaetocnema sp.

PERSEA AMERICANA Mill. (P. gratissima Green) (Alligator Pear, Avocado)

LEPIDOPTERA (Heterocera)

GEOMETRIDAE

Pingasa ruginaria Guen.

PYRALIDAE

Endocrossis quinquemaculalis Saub.

HEMIPTERA (Homoptera)

COCCIDAE

Fiorinia fioriniae Targ.

Icerya seychellarum Westw.

Pseudococcus filamentosus Ckll.

PHASEOLUS spp. (Patani, Lima Bean, Mungos, Green Gram, Habichuela, Bean.)

LEPIDOPTERA (Heterocera)

ARCTIIDAE

Palaeopsis diaphanella Hamps.

NOCTUIDAE

Mocis undata Fabr.

Thermesia rubicans Boisd.

GEOMETRIDAE

Hyposidra talaca Walk.

PYRALIDAE

Maruca testulalis Geyer

COLEOPTERA

CHRYSOMELIDAE

Pagria graphica Weise

COCCINELIDAE

Epilachna 28-punctata Motsch.

PSIDIUM GUAJAVA Linn. (Bayabas, Guayaba, Guava.)

DIPTERA

TRYPETIDAE

Dacus cucurbitae Coq.

Dacus ferrugineus Fabr.

HEMIPTERA (Homoptera)

COCCIDAE

Coccus viridis Green.

RAPHANUS SATIVUS Linn. (Rabano, Radish.)

COLEOPTERA

CHRYSOMELIDAE

Phyllotreta sp.

RICINUS COMMUNIS Linn. (Tangan-tangan, Castor Oil Plant.)

LEPIDOPTERA (Heterocera)

LYMANTRIIDAE

Lymantria mendosa Hubn.

SACCHARUM OFFICINARUM Linn. (Tuba, Caña Dulce, Sugar Cane.)

LEPIDOPTERA (Heterocera)

NOCTUIDAE

Sesamia uniformis Dudgeon.

PYRALIDAE

Scirpophaga virginia Schultze.

SOLANUM CUMINGI Dunal. (Tarambulo.)

COLEOPTERA

CHRYSOMELIDAE

Psylliodes balyi Jac.

Psylliodes splendida Har.

SOLANUM MELONGENA Linn. (Talong, Berenjena, Egg Plant.)

COLEOPTERA

CHRYSOMELIDAE

Aulacophora sp.

HEMIPTERA (Homoptera)

JASSIDAE

Nephotettix sp.

THEOBROMA CACAO Linn. (Cacao, Chocolate.)

HEMIPTERA (Homoptera)

COCCIDAE

Pseudococcus virgatus Ckll.

VIGNA spp. (Sitao, Cowpea)

LEPIDOPTERA (Heterocera)

PYRALIDAE

Lamprosema indicata Fabr.

COLEOPTERA

CHRYSOMELIDAE

Longitarsis manilensis Weise.
Pagria graphica Weise.

ZEA MAYS Linn. (Mais, Corn, Indian Corn, Maize.)

COLEOPTERA

CHRYSOMELIDAE

Chaetocnema sp.
Hespera sp.
Luperomorpha prolixa Erichs.

ANNUAL RÉSUMÉ OF THE CLINICAL ACTIVITIES OF THE COLLEGE OF VETERINARY SCIENCE[1]

By L. P. Koster and J. B. Ashcraft

WITH ONE PLATE

The value to a college of veterinary science of a successful clinic cannot be overestimated and is at once so apparent to even the most casual observer that any dilation on the subject seems superfluous; in fact it seems almost impossible to conceive of such an institution not including the operation of a clinic within the scope of its activities. So general is the acceptance of this premise without question or second thought that it may not be out of place here to devote some reflection to the matter and inquire into the causes for such an unanimity of opinion.

The prime motive of a veterinary college in conducting a clinic is likewise the most obvious one, that is, to augment and complete the instruction imparted to its students in the classroom and to afford them demonstrations of and opportunities to apply in actual practice the principles and theories of the lecture hall. The clinic is to the prospective veterinarian what the laboratory is to the student of chemistry.

Another advantage of great importance afforded by a clinic is the generous opportunity it offers for scientific inquiry and experimentation. Much of this would otherwise be possible only at great expense and observations would, in consequence, be restricted to a considerable degree. The clinic is a fertile source for the acquirement of new knowledge and a most prolific aid to the progress and advancement of the science.

Another aspect of a well conducted clinic is the advantage and benefit it confers upon the animal-owning population of the community in which the clinic is located. While this phase is incidental as far as the college is concerned, its value to the class mentioned cannot well be overstated.

The clinic of the College of Veterinary Science, University of the Philippines, is conducted daily between the hours of 10 and 12 a. m. and during the past year has been under the joint direction of the writers assisted by Dr. Miguel Manresa. During one month of the hot weather while the first two mentioned members of the staff were absent from the College direction of the clinic was assumed by Dean A. S. Shealy.

The present accommodations are temporary and consist of a large nipa shed with a concrete floor providing stabling for seven large animals and a dressing floor. The number of hospital cases has at various times exceeded the available quarters and to meet this demand a second temporary structure of light materials has been improvised adjacent to the principal shed. Small animals are confined in portable cages arranged in rows under the main roof.

The surgical equipment is complete in every detail, including operating tables for both large and small animals and an assortment of instruments which permits

[1] Experiment Station Contribution No. 93.

of the performance of any operation. A well stocked pharmacy is maintained affording ample facilities for medical treatment.

The object of the present paper is to present in related form such statistics of the clinic of the College of Veterinary Science of the University of the Philippines as will show the value thereof to the students of the College and indicate possible avenues of investigation. The data presented covers the school year July 1, 1921, to June 30, 1922.

PRESENTATION OF DATA

DISEASES ENCOUNTERED

The instructive value of a clinic is not only determined by mere numbers but also by the variety of diseased conditions and the range of species presented for treatment. A perusal of Tables I and II shows the medical and surgical cases met with during the past year at the clinic of the College of Veterinary Science and discloses a most gratifying condition in this regard. It will be seen that there were under medical treatment a total of 208 cases distributed among eight different varieties of animals and representing 64 different types of disease. A satisfactory condition is likewise revealed in Table II which shows that 75 different conditions of a surgical nature were encountered in 245 animals during the same period, distributed among ten species.

TABLE I.—*Classification of medical diseases and species*

Diseases	Species.								
	Horses	Dogs.	Carabaos	Cattle	Hogs.	Cats.	Fowls	Guinea pigs	Total
Acne.	1								1
Anemia, parasitic.				1					1
Anorexia			1						1
Anthrax			2						2
Arythmic cordis	1								1
Ascariasis	1	4	2					4	11
Botulism							3		3
Bronchitis, chronic	1								1
Bronchitis, verminous.					4				4
Catarrh, gastro-intestinal.	3			1	1				5
Catarrh, nasal, acute	1								1
Catarrh nasal, chronic	6								6
Congestion of the brain.				1					1
Congestion, pulmonary.	1								1
Coryza	6	1							7
Conjunctivitis		2	2		1				5
Distemper, Canine		5							5

Diseases.	Species.								
	Horses.	Dogs.	Carabaos.	Cattle.	Hogs.	Cats.	Fowls	Guinea pigs.	Total.
Eczema		5		2				4	11
Emphysema, alveolar	1								1
Enteritis, catarrhal	2								2
Epitheliosis, infectiosa avium (roup)							34		34
Favus				1					1
Fowl cholera							2		2
Fowl typhoid							1		1
Gastritis, catarrhal				2					2
Gastritis, chronic		1							1
Gastro-enteritis	1				1				2
Glanders	6								6
Glanders suspect	1								1
Hog cholera					6				6
Influenza	9								9
Impaction of rumen				1					1
Keratitis			2	5					7
Keratitis, parasitic			2						2
Laryngitis	1			1					2
Mange, follicular	2	2							4
Mange, psoroptic	2								2
Myositis			1						1
Obstipation		2							2
Oedema, stagnation	2								2
Osteomalacia							1		1
Osteoporosis	3								3
Otitis externus				7					7
Paralysis, facial	1								1
Paraplegia							1		1
Pharyngitis		1							1
Phthiriasis	1	3				1			5
Pneumonia	2				1		1		4
Poisoning, arsenic		1							1

Diseases.	Species.								
	Horses.	Dogs	Carabaos.	Cattle.	Hogs.	Cats.	Fowls.	Guinea pigs.	Total.
Uncinariasis		2							2
Urticaria	4								4
Rabies		1							1
Rabies suspect		1							1
Rheumatism, muscular	2								2
Rinderpest				1					1
Surra	4								4
Stomatitis	3								3
Strangles	1								1
Strongylosis	1								1
Taeniasis							1		1
Tetanus	1								1
Thrush	2								2
Toxemia							1		1
Tympanites				1					1
Total	72	31	12	24	14	1	45	8	208
Examinations, physical	5		2						7
Examinations for pregnancy	2								2
Grand total	79	31	14	24	14	1	45	8	217

TABLE II.—*Classification of surgical diseases and species*

Diseases.	Species.										
	Horses.	Dogs.	Carabaos.	Cattle.	Hogs.	Cats.	Fowls.	Goats.	Guinea pigs	Monkeys.	Total
Abscess, flank				2							2
Abscess, foot		1									1
Abcess, head									1		1
Abrasion, tail	2										2
Amputation, external ear				1							1
Arthritis, fetlock	1										1
Atresia ani										1	1

Diseases.	Species.										
	Horses.	Dogs.	Carabaos.	Cattle	Hogs.	Cats	Fowls	Goats.	Guinea pigs.	Monkeys	Total
Burn	1										1
Burn, rope			1		1						2
Bursitis, fetlock	4										4
Calculi, cystic					1						1
Capped hock	1										1
Carpitis	4										4
Castration	6	6	2	12		2		2			30
Contracture, flexor tendons	2										2
Contracture, suspensory ligament	1										1
Contusion	10			2							12
Cryptorchidism	1										1
Dehorning			1	1							2
Dystokia				1							1
Fibro-lipoma		1					1				2
Fistula, withers	1										1
Forging	4										4
Fracture, femur				1							1
Fracture, pelvis	1										1
Gall, saddle	3										3
Gall, collar	4										4
Gonitis	1										1
Granuloma				1							1
Heels, contracted	2										2
Hematoma				1							1
Interfering	1										1
Laminitis	4										4
Lipoma				1			1				2
Lymphangitis, epizootic	6										6
Melanosis	2										2
Metritis, septic					1						1
Myiasis dermatosa			2	6			1				9

Diseases.	Species.										
	Horses.	Dogs.	Carabaos.	Cattle.	Hogs.	Cats.	Fowls.	Goats.	Guinea pigs.	Monkeys.	Total
Oedema, traumatic	1		1								2
Orchitis	1										1
Ovariectomy.					1						1
Paraphimosis		1									1
Periostitis, metacarpal	1										1
Pododermatitis, acute	2										2
Prolapse, rectal.							1		1		2
Pyemia.							1				1
Ringbone	5										5
Sarcoma, vaginal.		1									1
Sesamoiditis	3										3
Shoe boil.	1										1
Spavin	6										6
Splint	3										3
Sprain, hock	1										1
Subluxation, patella.	3										3
Subluxation, tarsus							1				1
Step mouth.	1										1
Street nail, penetrating	14										14
Teeth floated.	32										32
Teeth truncated.	3										3
Tendinitis, acute	6										6
Tendinitis, chronic	4										4
Tendo-vaginitis	1										1
Trimming ears and tail.		3									3
Wavy mouth.	4										4
Wound, corneal	1										1
Wound, digital				5							5
Wound, fetlock	1										1
Wound, gunshot			2	1							3
Wound, head	2			3							5

Diseases.	Species.										
	Horses.	Dogs.	Carabaos.	Cattle.	Hogs.	Cats.	Fowls.	Goats.	Guinea pigs.	Monkeys	Total
Wound, metacarpal	3										3
Wound, penetrating facial				1							1
Wound, penetrating rumen.				1							1
Wound, tibial region					1						1
Wound, tarsal.	1										1
Wound, vaginal				3							3
Total	162	13	9	43	4	3	6	2	2	1	245

DIAGNOSIS

Both senior and junior students are required to attend clinic. The same cases are used for both classes, each case being assigned to a senior student, he having one or more juniors as assistants. Each group of students is held responsible for making a detailed examination of the patient assigned in a systemic and methodical manner and, with the assistance of the instructor, for making a diagnosis. The history of the case and the observations and findings upon which the diagnosis is based are recorded by the senior student on a hospital entrance chart and this chart is kept on file for future reference with all other records pertaining to the particular case.

One group of clinical students is assigned every two weeks to the pathology department for the purpose of conducting post-mortem examinations upon all cases which terminate fatally. The group is required to make laboratory examinations of specimens of diseased tissues and other material collected from cases in the hospital. The work is performed under the supervision of the department concerned and the findings are recorded on a laboratory diagnosis chart by the students.

The laboratory examinations are of immense value in establishing a prompt and accurate diagnosis as it is upon such determination that the course of treatment and subsequent method of handling the case depends. The specimens are of considerable teaching value in that they furnish material for showing the lesions of certain diseases, as well as the bacterial and parasitic causative agents, that could be obtained otherwise only with difficulty. The importance of laboratory examinations to the clinician in verifying, in modifying, or in refuting his tentative diagnosis has already been referred to and is not infrequently the cause of checking the spread and dissemination of destructive epizootics. Finally there exists the possibility that such examinations may reveal something that has not been before described or recognized. Reference to an instance illustrating this in a convincing manner will be found further on in this article.

TABLE III —*Laboratory diagnoses.*

Kind of examination	No. of examinations.	No. negative	No. positive	Findings. Organisms.
Blood	112	106	6	Trypanosoma evansi (4). Filaria immitus (2).
Fecal.	33	14	19	Taenia ova (2). Ascaris ova (10). Strongylus ova (1). Uncinaria ova (6).
Pus	7	3	4	Cryptococcus farciminosus (4).
Skin scrapping	35	25	10	Demodex folliculorum, canine (2). Demodex folliculorum, equine (1) Herpes tonsurans (1). Dermanyssus avium (1) Pulex serraticeps (2) Hematopinus equi (1). Psoroptes communis, equine (2)
Tissue.	8	0	8	Lipoma (4). Melanoma (2). Sarcoma (1). Granuloma (1)
Mallein test	10	4	6	

Table III shows that a total of two hundred and five laboratory examinations were made during the past year. While the bulk of this work was performed under the supervision and direction of Dr. L. C. Neer of the Department of Pathology, other collaborators who gave valuable aid and assistance were Doctors Schwartz and Tubangui of the Department of Parasitology of the College of Veterinary Science and Prof. H. E. Woodworth of the Department of Entomology of the College of Agriculture.

TREATMENT

The medicinal treatment of all cases is determined by the instructors in charge after soliciting suggestions from and discussing freely the case from all angles with the students. The instructor gives his reasons for selecting the drugs he has prescribed and the manner in which they should be administered. The prescription is written by the senior student in charge of the case following the directions of the instructor. The prescription is filled by another group of clinical students detailed to the pharmacy for periods of two weeks. Each prescription is signed by the writer and checked for accuracy by the student who receives and compounds it, the latter certifying to the fact by signing his name on the back of the form. These prescriptions are later carefully scrutinized by a member of the clinical staff and any irregularities are called to the attention of both the prescriber and compounder, who are required to correct and present the prescription to him for his approval. In such manner 270 prescriptions were compounded and dispensed by students during the year.

Surgical operations are performed by an instructor assisted by the students to whom the case happens to be assigned, except those operations which because of the frequency of their occurrence or their minor nature, the students are thoroughly familiar with and are capable of performing without detriment to the patient. In these cases every opportunity is afforded the student to improve his operative technique and to acquire self assurance and confidence in himself by being thrown upon his own resources. All major operations or those of a lengthy, painful character are performed under general anesthesia administered by the students assigned to the case. All work preparatory to the operation, such as shaving the field of operation and sterilizing both it and the instruments to be used, is accomplished by the students.

The senior student in charge of the case is required to fill out an operation chart describing in detail the immediately previous condition of the patient, the preparations for the operation, restraint, anesthetic, and instruments employed, the progress and nature of the operation, condition of the patient at the conclusion of the operation, and the dressing applied to the wound.

Daily treatment of cases both medical and surgical is administered by the students. A record of treatment procedure is entered on the daily hospital record on which appear also the results of the daily clinical examinations. The two charts relate the progress of the case from day to day and tend to develope the students' powers of observation and ability to interpret and appreciate the significance of any changes the patient may manifest. Effort is made to familiarize every student with each case admitted to the hospital. To this end re-assignments of cases are made at intervals of two weeks.

AUTOPSIES

During the year the department of pathology performed 69 post-mortem examinations. Eighteen of these cases do not appear in the records of the clinic as they were either brought to the hospital dead for the purpose of diagnosis or they were cases posted in the field. A thorough and complete post-mortem examination was made of all animals dying in the clinic, thereby enabling the students to check their clinical diagnoses and to become familiar with the morbid anatomy of the 37 different diseases encountered in autopsies of the year. Post-mortem instruction is of first importance to the students, training them in the technique of making the post-mortems, the detection of morbid changes, and the recognition of the death-causing disease.

Suitable and representative specimens of pathological lesions are preserved in the College Museum, increasing its usefulness as an aid in the teaching of pathology. The Museum while as yet small contains specimens of all the common conditions and its value continually increases as new specimens are added from time to time.

Below is a complete list of post-mortem findings for the year:

Condition.	*Number*
Anemia	3
Anthrax	3
Ascariasis	2
Botulism	1
Bronchitis, verminous	1
Congestion of the brain	1

Congestion of the lungs	1
Cerebritis, suppurative	1
Distemper, canine	2
Enteritis, hemorrhagic	1
Epitheliosis infectiosa avium	5
Filaria immitis	1
Fowl cholera	1
Fowl typhoid	2
Gastro-enteritis	1
Gastro-enteritis, mycotic	2
Gastro-enteritis, parasitic	1
Glanders	1
Hemorrhage, acute	3
Hog cholera	5
Impaction of intestines	1
Intussusception of intestines	1
Peritonitis	1
Pneumonia, catarrhal	1
Pneumonia, purulent	3
Pneumonia, verminous	1
Poisoning, mercurial	1
Poisoning, strychnine	8
Pyemia	2
Rabies	1
Rinderpest	3
Rupture of intestine	1
Septicemia	3
Surra	1
Strangles	1
Swine plague	1
Tetanus	1
Total	69

DISPOSITION OF CASES

Out of a total of 462 cases treated 283 or approximately 61 per centum were discharged from the hospital as cured. Ninety cases were undetermined. All of them, with the exception of one, were treated in the San Pablo Ambulatory Clinic where opportunity was not afforded for more than one treatment and consequently the outcome could not be ascertained. From the nature of their ailments, however, the probability is that all of these animals would have made a satisfactory recovery could treatments have been followed up for a reasonable length of time.

The death rate was relatively high due largely to the great proportion of fowls admitted to the hospital afflicted with infectious avian epitheliosa commonly known as roup. This disease runs a very grave course accompanied by a high rate of mortality and is responsible for a large number of the total deaths recorded. Another factor which contributed to this same result was the apparent reluctance of owners to bring their animals to the hospital before they had reached an advanced stage of disease or before the round of home remedies had been exhausted without producing results. Obviously such proceedure is highly prejudicial to chances of ultimate recovery and every effort is being made to correct this condition. Emphasis is being laid on the fact that everything connected with the treatment and boarding of the animal in the hospital is absolutely free of charge.

A substantial reduction in the death rate during the coming year is confidently looked for.

The following list shows the number and proportion for each disposition:

Disposition.	*Number.*	*Percentage.*
Number of cases discharged cured	283	61 2
Number of cases discharged improved	6	1 3
Number of cases discharged unimproved	3	.7
Number of cases destroyed	13	3 0
Number of cases died	51	11 0
Number of cases undetermined	90	19 4
Number of examinations	6	1 3
Number of cases still under treatment	10	2 1
Total number of cases	462	100 0

CONCLUSIONS

VARIETY OF SPECIES

To afford students a broad, well balanced veterinary education it is imperative that the cases offered by the clinic be well distributed as to species. The importance of this feature will be conceded at once and it is sufficient to say that a clinic restricted to but a few species of animals is seriously handicapped in its teaching facilities. The instructional value of the clinic to students is lessened in proportion to the decrease in number of species. Different species are affected with diseases peculiar to themselves and those diseases which affect more than one species are often exhibited in a modified and changed form in the different animals. Furthermore, the different species possess habits and characteristics which are peculiar to them and with which the student must be thoroughly familiar in order to become a successful diagnostician and clinician.

As the College of Veterinary Science is surrounded by an agricultural community and is in close proximity with the Department of Animal Husbandry of the College of Agriculture it is enabled to obtain in its clinic a representation of practically every domesticated species of animal which the student will encounter after his graduation. Such a location affords the advantage of closely simulating the conditions which the student finds in his native province. Such are, needless to say, totally at variance with those met with in an urban college.

The list inserted below sets forth the variety of species with the number and proportion of each that occurred in the clinic of the College of Veterinary Science during the past year:

Species	*Number.*	*Percentage.*
Horses and mules	241	52 17
Cattle and carabaos	90	19 48
Swine	18	3 89
Fowl	53	11 47
Goats	2	43
Total.—Economic animals	404	87 44
Dogs	44	9 52
Cats	3	64
Guinea pigs	10	2 16
Monkeys	1	21
Total.—Non-economic animals	58	12 53
Grand total	462	99 97

The conclusions to be drawn from the above data are:

(1) As regards variety of species the clinic of the College of Veterinary Science is most representative and complete.

(2) The proportion of species is well distributed according to their economic importance.

(3) The high predominance of economic over non-economic animals is significant of the utilitarian value of the clinic.

VARIETY OF DISEASES

The total number of diseased conditions listed in tables I and II is 139. Of this number 75 were of a surgical nature while the remaining 64 were of medical character. Of these 64, 13 were of an infectious character and 11 were of parasitic origin. The 13 infectious diseases embraced the following: anthrax, botulism in fowls, canine distemper, epizootic lymphangitis, fowl cholera, fowl typhoid, glanders, hog cholera, equine influenza, rabies, rinderpest, roup, and surra. The parasitic diseases included the following: ascariasis, parasitic anemia (cattle tick), verminous bronchitis, parasitic keratitis, follicular mange, psoroptic mange, phithiriasis, uncinariasis, strongylosis, taeniasis, and myiasis.

The above data indicate clearly what a heavy toll infectious and parasitic diseases exact from the live stock of the country and their economic menace. It also shows in a convincing manner how thorough and complete a representation of them is afforded by the clinic of the College.

The variety of sporadic conditions is sufficient and includes the most common affections of the class. Of special note in this connection is the relatively high number of cases of osteoporosis in horses which are recorded. This disease is characterized by a deficiency of lime salts in the bones and appears to be quite prevalent in the Philippines, at least in the vicinity of Los Baños.

The number of surgical cases is slightly in excess of medical cases and sufficient variety is afforded for teaching purposes. There is an ample number of cases of lameness varying in type, location, and degree to furnish frequent demonstrations and opportunity for thorough exercise in diagnostics.

NEW AND UNUSUAL CONDITIONS

Special interest is attached to some of the cases treated in the clinic during the past year because of their rare occurrence or for the reason that they presented some peculiarity in their course.

A new form of myiasis was encountered which was studied in some detail and on which a paper is now in preparation and about to be published by Professors Woodworth and Ashcraft.

Several cases of a heavy infestation of carabao calves with *Ascaris vitulorum* were treated with varying success. This condition promises to be of great economic importance as it is believed to be widespread in the Islands and to be the cause of a serious loss in young carabaos. To determine its extent and the best means of combating it requires considerable experimentation which it is hoped the College will soon be able to undertake. Further information on this condition is contained in the following articles by Dr. Benjamin Schwartz, of the College of Veterinary Science:

Observations on the life history of *Ascaris vitulorum* and the effects of extracts of *Ascaris vitulorum* on experimental animals. Philippine Journal of Science. (In press.)

Ascarid infestation of domesticated animals in the Philippine Islands. Philippine Agricultural Review. (In press.)

A monkey caught on Mount Makiling was found to be affected with atresia ani. The condition had evidently existed for some time and caused so great a depression in the animal that his capture was easily effected. Only the skin being imperforate, an operation was performed. The patient, however, succumbed two days later. Death was due to enteritis as was revealed by post-mortem examination.

Some very troublesome cases of otitis externus occurred in the Hereford cattle of the College of Agriculture. This condition was caused by maggots of the oriental screw worm fly *Compsomyia dux* Esch. and from its nature and the frequency of its occurrence it is believed that the fly was attracted to the ear by the presence of blood from crushed cattle ticks on the skin of the ear. The Herefords were quite heavily infested with ticks and in one case, that was discovered early, the crushed body of a dead tick was found attached to the hairs growing from the inside of the ear. The blood from its body covered a small area of skin on the internal surface of the ear and in this area one larva was found.

VOLUME OF CLINIC

While the number of cases in the clinic of the College of Veterinary Science is admittedly small and could with great advantage be increased, it must not be inferred that this is an inherent condition. Time alone will furnish the corrective for this deficiency and continual and progressive improvement in this direction is occurring constantly. In this connection it must be remembered that the clinic has been in operation for the short period of twenty months. As evidence of its increasing and vigorous growth the following figures are cited.

During the first eight months of the clinic's operation, from November, 1920, until the end of June, 1921, a total of 151 cases were admitted to the hospital, a monthly average of slightly less than 19 cases,

During the calendar year of 1921 a total of 356 cases were admitted, a monthly average of slightly less than 30 cases.

During the past academic year, from July 1, 1921, to June 30, 1922, from which the material for this résumé was drawn, a total of 462 cases were treated, a monthly average of 38.5 cases.

However, the teaching value of a clinic is not, as has been previously stated, entirely dependent upon the number of cases it supplies. Its real value lies in the opportunity it affords students of observing and studying cases until their recovery or death and, if the latter, of making a careful and thorough post-mortem examination. The number of "in cases," those quartered in the hospital during treatment, is in the clinic of the College of Veterinary Science very high (about 70 *per centum*) and so affords a proportionately greater opportunity for realizing the advantages of continuous logical treatment than is ordinarily the case in most clinics. This condition compensates in great part for what appears to be a serious shortage in numbers and makes more apparent than real any shortcoming in this direction which may be charged against the clinic.

ILLUSTRATION

PLATE I

A class in surgery. Clinic of the College of Veterinary Science.

PLATE I A CLASS IN SURGERY CLINIC OF THE COLLEGE OF VETERINARY SCIENCE

REVIEW

La vaccination contre la peste bovine, René van Saceghem (*From Comptes Rendus des Séances de la Société de Biologie 85: 878-9, 1921*).—Vaccination against rinderpest is one of the questions that is set down for to-day's discussion. The recent epizootic of rinderpest in Belgium, where, thanks to energetic measures, we succeeded in arresting it, and the epizootic of rinderpest which rages in East Africa, raise a series of questions which have a special bearing on the organization of the struggle against this pest. The struggle against this terrible scourge is based on various police sanitary measures, and more particularly on vaccination and serum immunization. The method of vaccination universally adopted is that of Kolle and Turner and is known as the simultaneous method. It consists in injecting cattle subcutaneously with rinderpest virus and immunizing serum, in two simultaneous injections. The question as to the quantity of virus and serum that are necessary to obtain a good vaccination has given rise, recently, to very lively discussions. Kolle and Turner recommended 0.66 cc. of rinderpest blood, withdrawn on the 5th day after the onset of the disease, and from 25 to 50 cc. of serum, depending upon the weight of the animal. The method of Schein also consists in two simultaneous injections but the quantity of rinderpest blood formerly injected is replaced by 1 cc. of a 1 to 1,000 dilution of rinderpest blood in anticoagulating physiological salt solution. The quantity of serum used is 50 cc. per 100 kilogram of weight of the animal to be vaccinated. Croveri, who has discussed the experiments Schein, proves that this procedure is not applicable to live-stock in Somalie and I am certain that it would yield no results in live stock in Ruanda. That the enormous quantity of serum injected by Schein neutralizes the weak quantity of virus, is beyond any doubt.

In practice it is very difficult to determine the real strength of the two important factors, namely, virus and serum. If, for a given dose of serum the virus that is injected is too much or too virulent, the serum cannot attenuate the disease and the animal dies of rinderpest. If, on the other hand, the given dose of virus is too weak or too small, the serum neutralizes it and there develops neither disease, vaccination nor immunity.

Moreover, I have observed that very often vaccination produces among feeble animals an apyretic condition, which always terminates fatally.

After six months of observation I have come to the conclusion that vaccination by the simultaneous method presents great disadvantages and gives very uncertain results. I must acknowledge that rinderpest virus can develop and produce the disease, in a so-called attenuated form, with a rise in temperature that persists for several days, with all the symptoms of rinderpest, resulting in the persistence in the organism of anti-rinderpest antibodies brought in by the inoculated serum. These antibodies, injected simultaneously with the virus, would, in my opinion, be rapidly neutralized, at least so far as concerns their anti-virulent properties. Serum injected simultaneously with virus ought to neutralize part of the virus and the disease should develop as if it had been produced by a smaller quantity of virus than that actually injected, thus causing the disease to run a milder course.

I have actually used successfully a new method of vaccination in place of the simultaneous method. This method consists in injecting very small doses of virus (1/10 cc. for animals in Ruanda); I allow the disease to develop naturally and on the second day after the onset of fever I inject 50 cc. of serum into the jugular vein. My experiments have proven that the intravenous method of injection is better than the subcutaneous.

The big advantage of this method consists in avoiding great dangers inherent in the former method of vaccination. We do not run the risk of neutralizing the virus, because we inject serum only when the disease is developing. Injection of serum when the animal is beginning to react to the disease aids the organism at the proper time, whereas in the simultaneous method of injection the serum frequently acts as a paralyzer of the defense system.

—*Translated by B. Schwartz.*

COLLEGE AND ALUMNI NOTES

Professor R. W. Barney of the University of Hongkong spent ten days at the College of Agriculture in July collecting Lepidoptera.

Associate Professor F. P. McWhorter has been transferred from the Department of Plant Physiology to the Department of Pathology. He will act as head of that department during the absence of Professor Reinking.

Associate Professor Nemesio B. Mendiola and Mr. Leon Gonzalez made a fruit study trip to the Lamao Experiment Station and another to Trinidad, Benguet, to look over the vegetable gardening work in the Trinidad Farm School. Professor Mendiola in May also made a trip with Mr. Vicente Aldaba through the provinces of Tayabas, Camarines Sur and Albay, as far as Tabaco to study local methods of abaca cultivation and gather data on which recommendations on hill selection may be based.

First-Lieutenant P. C. Sevilla arrived at the College on July 4 to take charge of the Department of Military Science and Tactics.

Letters reaching the College announce that I. Collado of the Class of 1919 will soon be returning to the Philippines. He is at present studying in the Illip School of Theology, Denver, Colorado, U.S.A.

Rufino Cuitiong, Class of 1922 of the College of Agriculture, died in the General Hospital on Aug. 19, 1922, at 3:00 p. m., as a result of an automobile collision.

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THE PHILIPPINE COTTON BOLL WEEVIL

By H. E. Woodworth[1]

Of the Department of Entomology

WITH ONE PLATE

The subject of cotton pests has apparently received little attention in the Philippine Islands. In fact so little is known of the insects affecting the cotton plant here that its most serious pest, *Amorphoidea lata* Motsch., does not appear in economic entomological literature, with the possible exception of a short note by Hunter and Hinds (1), who apparently knew of the occurrence of a cotton boll weevil in the Philippines as witnessed by their statement that "In the Philippines there has been found a species of weevil which is distinct from the Mexican cotton boll weevil, but attacks cotton in a very similar manner." In the interest of the Philippine cotton industry and for the information of quarantine officials throughout the world, a study of the life history and habits of this pest was undertaken in June, 1921.

DISTRIBUTION

Amorphoidea lata was originally described by Motschulsky (2) in 1858. He records it from "India Or." Gemminger and Harold (3) list it from the same locality although it is not mentioned in available Indian literature, and Ramakrishna Ayyar (4) in a recent paper of the "Weevil fauna of South India with special reference to species of economic importance" does not include it. Schultze (5) lists it from Manila, Luzon, on the basis of specimens determined by K. M. Heller. Specimens are in the Bureau of Science collection from Maao, Occidental Negros, and Manila, Luzon. In the collection of Dean C. F. Baker it is recorded from Sibuyan, Romblon; and Surigao, Mindanao. I have collected it from Los Baños, Laguna, and San José, Mindoro; and I have specimens from Taal, Batangas, and Ilocos Norte. There is little doubt but that it will be found spread throughout the Islands, not only from the evidence of widely scattered collection localities, but also from the fact that it breeds naturally in at least one native wild food plant in addition to the cultivated cottons.

LIFE HISTORY

Egg.—The egg is smooth pearly white (Plate I, Fig. 2). Considerable variation in shape from elliptical to ovoid has been observed. Average size from a

[1] Experiment Station Contribution, No. 94

series of measurements is .64 by .44 mm. They are laid in the tissue of the opened flower, in the sheath of the ovary or staminal column (Plate I, Fig. 1). The female excavates a small cavity in the tissue of the staminal sheath with her snout, and, reversing her position, deposits a single egg in this cavity. Several eggs may be deposited in each flower. Table I shows the number of eggs found in cotton flowers on the College of Agriculture campus.

TABLE I.—*Showing the number of eggs deposited in mature cotton flowers.*

Number of eggs..........	0	1-3	4-6	7-10	11-15	16 or more	Average 5.1
Number of flowers.......	62	31	24	38	37	8	Total 200

Table II shows the incubation period for 150 eggs deposited at different times of the year. Considerable difficulty was encountered in obtaining these data since it was necessary to observe the actual oviposition.

TABLE II.—*Showing the incubation period for eggs of Amorphoidea lata Motsch.*

Number of days	1	2	3	Average 1.5
Number of eggs.	73	71	6	Total 150

Larva.—The larvae are wrinkled, grayish-white, crescent-shaped, legless grubs, with a few scattered darker hairs. The head is slightly smaller than the body, brown, pale when first hatched and darker later. Length 4 mm., breadth 1.2 mm., when mature (Plate I, Fig. 3). Immediately after hatching, the young larvae bore directly into the ovary. If the egg is delayed in hatching, the grub never gets into the ovary and consequently dies, for the sheath drops off in from three to five days after the flower opens. The larvae feed upon the tissue in the ovary and completely destroy one or more of the ovules. As many as nine larvae have been found in a single boll. In most cases the infested fruit drops to the ground before it matures, usually a few days after the flower drops. Some time previous to pupation, the larvae leave the fruit and enter the soil. When a fruit is too heavily infested with grubs, it drops to the ground while it is still so small that there is not sufficient food for the larvae. In such cases the grubs do not mature. With normal or average infestations the food is just sufficient to supply the larvae for the short feeding period. There appears, however, to be some slight ability to adapt themselves to a curtailed food supply, which may account, in some degree at least, for the variation in size found among the adults.

In addition to the feeding stage of the larval period, there is a distinct resting stage which is spent in the soil. The length of the resting stage does not appear to be quite so variable as does the feeding stage, due again, perhaps, to adaptability to variations in available food supply. Table III shows the length of time spent in the larval stage under laboratory conditions.

TABLE III.—*Showing the length of the larval stage of Amorphoidea lata Motsch.*

Feeding period.	Number of days........	2	3	4	5	6	7	8	Average 3 4
	Number of larvae......	40	47	28	34	0	0	1*a*	Total 150
Resting period.	Number of days	2	3	4	5	6	7	8	Average 3 2
	Number of larvae......	12	103	28	6	0	0	0	Total 149
Total larval period.	Number of days........	5	6	7	8	9	10	11	Average 6 6
	Number of larvae......	36	36	28	47	2	0	0	Total 149

a The grub died after feeding in the ovary for eight days.

Pupa.—The pupae are naked and resemble the adults generally as to form. They are grayish-white with a few scattered darker hairs. The eyes are chocolate brown and the mandibles are dark. The elytra are grayish black, much darker than the rest of the body (Plate I, Fig. 4.). Pupation takes place in the soil at a depth of from 1 to 2 cm., depending upon the texture of the soil. No definite pupal chamber is made. Table IV shows the length of the pupal stage from a series of breedings.

TABLE IV.—*Showing the length of the pupal stage of Amorphoidea lata Motsch.*

Number of days..	3	4	5	Average 3.7
Number of larvae..	46	96	7	Total 149

Adult.—Head minutely and shallowly pitted, pale to reddish brown and sparsely pubescent; eyes lateral, convex and nearly circular. Rostrum about as long as prothorax, sides parallel. Antennae light brown arising from middle of rostrum, elbowed, clavate; joint 1 almost as long as all the succeeding, resting in a grove on the basal half of the rostrum and reaching to the eye, 9 greatly swollen and more pubescent. Prothorax 1½ times as broad as long, sides rounded, broadest in middle, narrowed slightly behind and strongly constricted anteriorly, minutely pitted, and pale, with fine sparse golden pubescence below. Scutellum present. Elytra ovate, chocolate, with golden brown scales, not covering last abdominal segment, striate, and finely pitted. Abdomen below, and legs pale with golden pubescence. Length 3.5 mm.; breath 1.2 to 1.7 mm.

The adults (Plate I, Fig. 5), rest for a day or so after emerging, often several days, then start feeding upon the flowers of the various food plants. They enter the flower when it first opens and the attack continues until it matures and falls. Copulation takes place within the flowers and the process does not seem to interrupt the feeding of the female. In the cotton fields of the College of Agriculture campus, up to thirty beetles were found in the flowers, and very few mature flowers were observed without at least one beetle. Table V shows the relative attack on unopened buds, newly opened flowers, and mature flowers.

TABLE V.—*Showing the infestation of cotton flowers by Amorphoided lata Motsch.*

Age of flowers.	Number of flowers.	Number of beetles.	Number of beetles per flower.
Buds	140	120	0 8
Newly opened flowers	405	688	1.7
Mature flowers	482	39	0.08

Considerable variation as to size and color in the adults was observed. As a rule the males are smaller, but too much overlapping in size occurs to use size as a character for distinguishing the sexes. Size variation in this beetle is not entirely sexual. Similar variation without definite relati n to sex has been observed in the case of the Mexican cotton ball weevil (1). And similarly with the Mexican cotton boll weevil, dissection is the only definite means of differentiating the sexes, except when they are found in copula.

No information is at hand relative to the longevity of the adult under normal conditions. Specimens confined without food in a moist chamber with soil, lived for a period of from 4 to 12 days. In jars without moisture they died in from 1 to 3 days, a few lived beyond the third day. Unless there are other host plants than those observed, the weevil must hibernate for a considerable period of the year, since during the season from June to October neither host plant is normally in bloom.

Summary.—If food is available, there is a continuous series of generations throughout the year. Cotton plantings on the College of Agriculture campus have furnished a continual supply of larval food and the length of the life cycle does not materially vary in any part of the year. Table VI is a summary of the life breeding experiments carried out under laboratory conditions.

TABLE VI.—*Showing the life cycle of Amorpho dea lata Motsch.*

	Egg stage, days.	Larval stage, days.	Pupal stage, days.	Total days.
Minimum	1	5	3	9
Maximum	3	9	5	17
Average	1.5	6.6	3.7	11 8

FOOD HABITS

Larval.—The eggs of the weevil are so placed that the normal food is immediately available. The larvae eat their way through the remaining part of the ovary sheath and into the ovary itself. In the ovary they feed upon the tissue of the ovary wall, the placentae, the ovules, and the immature fiber. Usually the entire contents of the ovary are eaten before the larvae leave it to pupate. Hunter and Hinds (1) described *Anthonomus grandis* larvae as feeding upon the square, especially in the younger larval stage. Observations on *Amorphoidea lata* larvae show that such is not the case with the latter species, that they are practically always found within the ovary. Larvae which hatch from the egg after the square has fallen, die.

Adult.—A few days after emergence, the adults commence feeding. They attack the petals, stamen, and pistil. The petals are eaten through and often badly riddled, especially near the base. The stamen and anthers are cut off or devoured, and the pistil is sometimes entirely destroyed. The attack on the flower parts often results in the early falling or rotting of the flower. Attacks on young bolls may destroy the boll completely, or may cause it to drop prematurely. Attacks on the older ovaries are usually of less importance. The punctures are visible as small spots on the surface of the fruit, caused by the healing over of the wound. No attack on leaves or stem has been noted.

FOOD PLANTS

All species and varieties of *Gossypium* grown on the College of Agriculture campus during the last two years were attacked by both the larvae and adults of *Amorphoidea lata*. The following cotton varieties at Los Baños have been noted as hosts:

1. C. A. 16912—From Chieng, Mori, Siam.
2. C. A. 10253—From Zamboanga, Mindanao.
3. C. A. 17105—Batangas white.
4. C. A. 17630—Batangas brown.

It has been found to be serious pest of all the cultivated cotton varieties grown in the province of Ilocos Norte and Batangas. No figures are available as to the relative susceptibility of the varieties, but it is possible that any varieties, the square of which would fall very soon after opening, would exhibit a smaller degree of infestation, as the square must remain until the eggs hatch in order that the larvae may get into the ovary and develope. This point is worthy of further investigation.

The only wild host plant observed was *Thespesia lampas* (Cov.) Dalz & Gibs. (Marakapas.) Heavy infestations of fruits and flowers were noted at Los Baños, Laguna, and San José, Mindoro. This plant is widely scattered in the Philippines and appears to be a natural host for the weevil. No preference is shown between cotton and Marakapos. No larvae and but few adults have been observed on *Thespesia populnea* (L.) Corr.

Adults were found in the flowers of the native gomamela (*Hibiscus rosa-sinensis* Linn.) but the larvae would not develop on this plant. Possibly other closely related *Malvaceae* may furnish food for the adults, but none have been observed as hosts. A decided preference was noted for cotton over gomamela flowers. In cages, the adults invariably left the gomamela flowers upon the introduction of cotton flowers.

IMPORTANCE AND POSSIBILITIES

There is considerable difficulty in estimating the damage produced by the cotton boll weevil, occuring as it does on what is minor crop in the Islands and one upon which no comprehensive production figures are available. In all of the cotton growing regions of the Philippines, the weevil is abundant. A large percentage of bolls fall to the ground and never mature. Some data are summarized in Table VII which indicate that the principal cause for the dropping is weevil injury.

TABLE VII.—*Showing the infestation of young fallen cotton bolls by the larvae of Amorphoidea lata Motsch.*

Date 1922.	Number of bolls collected.	Number of bolls with weevils.	Number of bolls without weevils but showing injury	Number of bolls with no sign of weevil attack
April 19.	20	11	9	0
April 20.	12	8	4	0
April 21.	20	12	4	4
April 22.	15	5	9	1
April 23.	16	11	5	0
April 24.	17	12	5	0
April 25,	22	17	5	0
Total	122	76	41	5

Bolls attacked by weevil grubs fall to the ground and never produce mature seeds or fiber. The great abundance of the pest must necessarily result in a correspondingly large loss in cotton production. From observation it seems that this weevil is the most serious insect enemy of cotton in the Philippine Islands, despite the fact that among the other pests attacking cotton here may be listed such important insects as the pink boll worm (*Pectinophora gossypiella* Saund.), the green plant bug (*Nezara viridula* Linn.), the cotton leaf roller (*Sylepta derogata* Fabr.) and the oriental cotton stainer (*Dysdercus megalopygus* Bredd.).

Injury by adult weevils is far less important than is the larval damage. In some cases they may destroy the flowers, and in a few instances, cause the destruction of the very young bolls. The principal effect of the adult attack seems to be that of causing the flower to drop much earlier than it normally would. It appears from the knowledge that the eggs are laid in the flower parts and that the young larvae must hatch and get into the ovary before the flower drops in order to live, that, unless the early falling of the flower affects the development of the boll, the adult attack is somewhat beneficial.

While all the cotton growing regions of the Philippines are probably already infested with the boll weevil, if there are any which are not, no effort should be spared to avoid infesting them. Unfortunately the extent of distribution of the various economic species in the Islands is not known, and any internal quarantine, to be effective, must be based upon such definite knowledge. For this reason, as well as for many others, a pest survey of the Philippine Islands is one of the pressing needs of economic entomology here today.

The possibility of introducing this pest into foreign countries seems rather remote. The exceedingly short life history period eliminates the danger of introduction of the larvae by means of seed. Further, infested bolls never mature, and thus seed cotton would not contain the grubs. Some danger is present in shipping the adults along with plants, soil, seeds, or raw cotton. Practically no danger exists from ginned cotton. Care should be exercised to see that all raw cotton, seed, plants, and soil are free from the pest before shipment.

SUMMARY

1. *Amorphoidea lata* Motsch., is found in Manila, Laguna, Batangas, Mindoro, Ilocos Norte, Romblon, Mindanao, and possibly in other provinces of the Philippine Islands.

2. The various stages of the weevil are described, and records of breeding experiments are included, showing that the average length of the life history is from eleven to twelve days.

3. The larvae feed in young cotton bolls and completely destroy them.

4. Adults feed upon the flower parts, but the injury is of minor importance.

5. The larvae are found on all varieties of cultivated cotton and on *Thespesia lampas* (Cav.) Daltz & Gibs. (Marakapas).

6. The adults feed on the flowers of other *Malvaceae* as well as on the larval food plants.

7. The weevil is the most important insect pest of cotton in the Philippine Islands.

8. There is little danger of the weevil being introduced into other countries by cotton shipments. Some slight danger exists in transporting the adults in raw cotton, packages of seed, plants, or soil.

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ILLUSTRATIONS

PLATE I

Lower Left Figure. Egg *in situ*.
Lower Center Figure. Egg x 30.
Upper Right Figure. Larva x 20,
Upper Left Figure. Pupa x 15.
Lower Right Figure. Adult x 17.

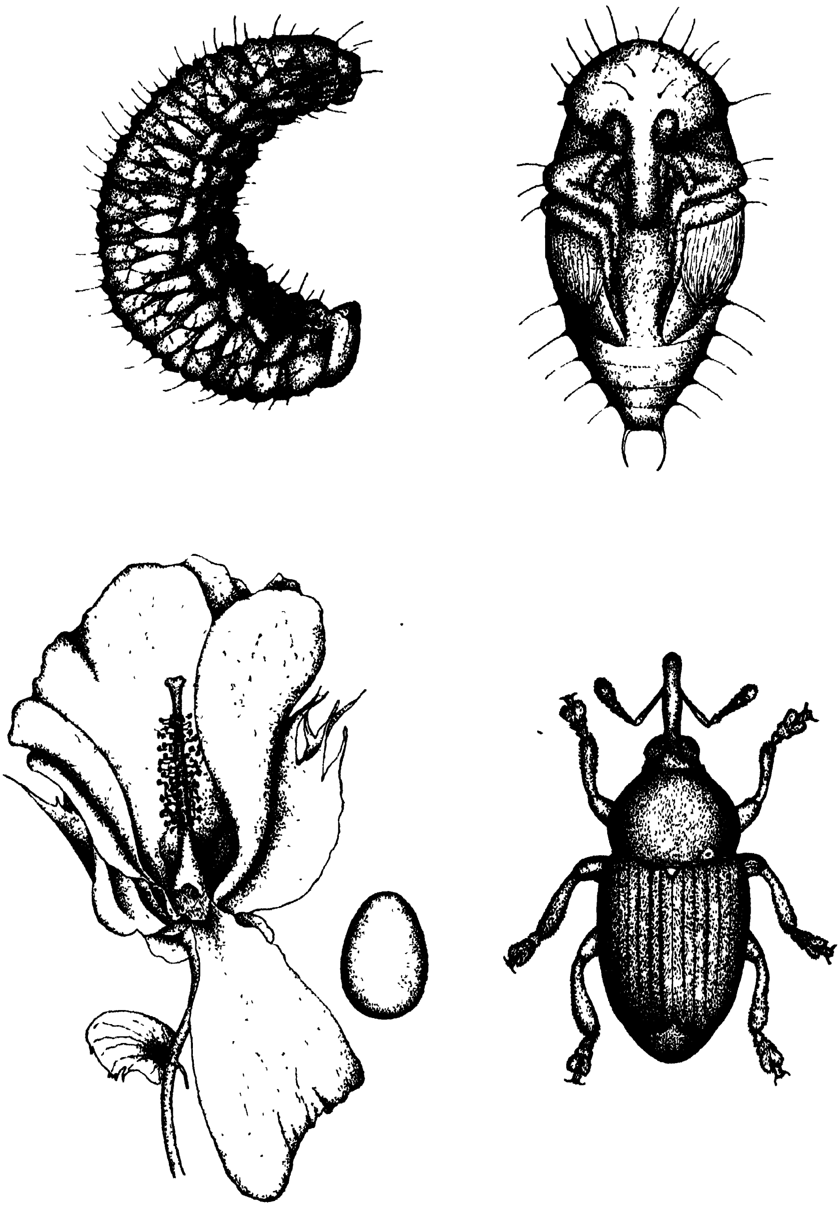

PLATE I.

COLLAR INJURIES: THEIR CAUSE AND PREVENTION

By Louis P. Koster[1]

Of the Department of Veterinary Hygiene

Excluding specific diseases and lameness, it would be difficult to point to a greater source of inefficiency and enforced idleness of horses than that of injuries inflicted upon their shoulders by poorly fitting collars. It is by no means an uncommon sight to see horses in perfect health and otherwise in the very pink of working condition rendered useless for considerable periods of time because of these injuries. Such injuries result in much discomfort and annoyance to the animals, a material decrease in their efficiency, and a distinct economic loss to the owner. At the same time there is probably no condition which is in so large a measure preventable and which may, with the exercise of judgment and discretion, be so easily and completely avoided.

It is true that a few horses by reason of the conformation of their shoulders, their physical condition, or the nature of their work are predisposed to this class of ailment. However, it may be safely ventured that the majority of cases results from a lack of knowledge as to what is required for the proper fitting of a collar, rather than from the horse himself or from the carelessness or indifference of the attendant. A thorough knowledge of the anatomical structures involved and the modifications which occur in the parts as a result of locomotion are prerequisites to a clear conception of the subject of collar fitting.

It may be accepted as axiomatic that collar injuries are the effect of a definite cause and are never of accidental occurrence. If the cause be removed the effect will disappear. Analysis leads to the conclusion that the cause must be one of two factors; either pressure or friction on the injured part. How to recognize which of these two factors is the cause, detect the means by which it is operating, and finally the manner in which it may be overcome are, therefore, very pertinent questions.

In presenting this article to the readers of *The Philippine Agriculturist* the endeavor of the writer has been to set forth the knowledge he has gathered on the subject both from reading and experience with the hope that it may prove of service to those having horses under their care.

TYPES OF COLLARS

There are two types of collars in common use; the breast or Dutch collar and the full or neck collar. The former is the simpler type but is only suitable for the lightest draft. It is rarely the cause of any damage to the shoulders. The full collar is the great offender and this paper is restricted to a consideration of that type.

CONDITIONS OF COLLAR FITTING

The horse's requirements in regard to collar fitting may be more readily understood if a few observations are borne in mind concerning the shape and structure of the shoulders and the movements which they undergo.

[1] Experiment Station No. 95

Upon viewing the horse at rest a distinct depression is seen at the line of junction of the neck with the shoulders. The collar rests in this depression and because of this fact it is commonly known as the collar bed or collar rest. The deeper and more hollowed-out the depression, the more flatly and evenly the collar will lie against the anterior borders of the shoulder blades. A collar resting on such a bed insures an even and uniform distribution of weight over the shoulders when resistance is thrown against them in the performance of draft and it represents the type of shoulder best adapted for this work.

The shoulders and necks of horses, however, vary in their size and shape almost as much as the heads of people and no two are exactly alike in this respect. In some necks the crests are found very thick and wide from side to side while in others the opposite is the case. In some horses the necks are very thin in the middle, while in others the musculature is large and well developed. Similar examples might be given at length but the two cited are sufficient to show the necessity of each horse having its own individual collar made to measure if its shoulders are to be kept in a sound condition. If possible a horse should always be fitted with a collar when he is in working condition. It is often surprising to observe how collar requirements vary in cases where fat is gained in idleness or good feeding and where it is lost by work. When horses are worked very early in life before they have attained their full growth, as is often the case in the Philippines, the shoulders increase in width and depth so that frequent changes to larger collars are necessary.

Before entering into the details of collar fitting attention must be given to the movements of the shoulders in locomotion and the bearing which they have upon the subject. On inspecting the animal's shoulders while at rest, the collar bed is found to consist of two perfectly parallel shoulder surfaces against which the collar is flatly apposed. When the horse is in motion this aspect is entirely changed as the shoulder blades are constantly and alternately moving backward and forward. While one shoulder is coming forward the other is going backward so that the collar is at no time actually resting on flat parallel surfaces such as are presented by the two shoulders at rest. The shoulder surfaces are always oblique. As a result of this movement considerable oscillation of the collar is produced. A collar also rises on the shoulders when a horse puts its weight against it, although this occurs to a less extent with upright shoulders than with more oblique ones.

The oscillation of the collar as a result of shoulder movements is the most important cause of collar injuries. The oscillation results in friction between the collar and the parts beneath and as a sequel abrasions of the skin occur which increase in extent and severity unless the cause is promptly removed. The collar should fit so closely that but little oscillation or lateral movement is possible but not to the extreme, however, of pinching the sides of the neck.

THE FITTING OF THE COLLAR

In examining the fit of a collar the following are the essential points to which attention must be directed:

(1) The collar should lie flatly against the shoulders and settle into its position easily If any effort is required to force it into place the width is insufficient and injury to the sides of the neck will certainly follow its use.

(2) It should be observed that the collar has a level and even bearing over all parts of the collar bed from top to bottom. To ascertain this the top of the collar may be grasped with one hand and the bottom or throat with the other. The collar may then be pressed back firmly against the shoulders and no rocking or see-saw motion should be possible. If such is possible it indicates that the center of the body of the collar contains too much stuffing.

(3) Between the collar and the neck just in front of the withers there should be a space sufficient to permit the insertion of the flat of the hand.

(4) Between the inside of the collar and the sides of the neck the fit should be so close that the space which exists will admit the flat of the fingers and no more. This space should be found from the top to the bottom of the neck. Care should be observed that the fit is not so close as to pinch the sides of the neck. Quite frequently the proper space is found at the upper part of the neck but between its lower third and the collar the space is too great. This results in too much play, which of course means friction with its attendant evils.

(5) The amount of lateral motion in the collar is ascertained in the following manner: Taking hold of the collar at the top and bottom with both hands as in (2) it is pressed firmly back against the shoulders and worked from side to side. About the shoulder joint the movement should not be as much as two inches. This amount or anything in excess of it is an indication that the collar is too wide and damage to the shoulders is certain to follow its use.

(6) The depth of the collar is important and must be examined. In draft, especially up-hill, the collar rises on the shoulders, hence the necessity of having the throat of the collar well away from the neck when the animal is at rest. If the collar be too short when weight is thrown against it, undue pressure is caused on the trachea thereby impeding the breathing. To test the depth of the collar insert the flat of the hand between the throat of the collar and the horse's neck. If the collar is deep enough the hand and wrist should find ready admission; anything more is unnecessary and even undesirable. Too deep a collar is objectionable because it gives rise to additional friction.

(7) The bearing surface of a collar should be hard and smooth. The body can hardly contain too much stuffing providing it is well placed as this insures the pull of the load being evenly distributed over a large surface. Moreover, continuous wear compresses the stuffing so that the body becomes flatter. Not infrequently in old collars this allows the edge of the afterwale to extend beyond the body of the collar and come in contact with the skin of the shoulder. This point must not be overlooked if the examination is to be thorough.

(8) The hames should fit accurately into their groove and conform strictly to the shape of the collar in their curvature. If the hames are too straight a collar which fits well without them will be found too tight when they are applied. The hames considerably increase the rigidity of the collar and help to close those which are open at the top. They are not in themselves sufficient to effect this, however, and a housing strap must accompany this type of collar. The strap should be drawn as tightly as possible, as should also the hames strap in order to prevent the hames from sliding about or coming out of their groove.

(9) With a properly fitted collar the attachment of the traces to the hames should be such that a pull as nearly as possible at right angles to the line of resistance is effected. Then the collar will bear directly against the shoulder and not

be borne down upon the withers nor up against the trachea. Furthermore, the height at which the attachment of the hames is made should be such as to distribute the bearing proportionately over the collar bed and to allow the greatest freedom of shoulder motion. If the traces are attached too high the greatest weight is borne upon that part of the collar bed which is least capable of sustaining it. If attached too low, as is most commonly the case, the movements of the shoulders are hampered and a backward and forward motion is given to the collar. The trace attachments to the hames must be of equal height. It is not uncommon to observe one trace attached higher or lower than the one on the opposite side.

COLLAR INJURIES AND THEIR PREVENTION

There is no part of the neck and shoulders entering into the formation of the collar bed which may not suffer damage as the result of a defective collar. The severity of the injuries produced ranges from mere skin abrasions in the mildest form to actual involution of the bone in the most aggravated cases. Occasionally, abscess formation occurs about the region of the shoulder joint around which, as a center, grow large, hard, tumified masses of connective tissue resulting often in permanent deformity of the shoulders. The location of the injury is of significance in indicating what part of the collar is at fault. An intelligent inspection of the fit of the collar about this region should readily reveal the trouble and the means of rectifying it. A brief description of the more common collar injuries, their location, nature, cause and prevention follows:

(1) The injury which occurs at the top of the neck just in front of the withers is a particularly painful one, so much so that one may encounter great difficulty in approaching the animal to make an examination. In some cases the sensitiveness is so great that the animal shows alarm when one merely points at the part even though the affected surface is no larger than the thumb nail. Injuries at this location furnish the one example of collar injury due to pressure. All others are invariably the result of friction. This injury resembles those sustained by the back in this regard and also in the similarity of the lesion produced. A circumscribed area of skin frequently undergoes necrosis in much the same manner as in the formation of a sitfast.

The usual cause of this injury is a collar not completely closed at the top thus allowing it to slide down on the shoulders so that its entire weight is suspended on the top of the neck. For this reason the housing strap closing the top of the collar should be drawn as tightly as possible. A space as described in (3) above should exist between the neck and the collar for equally obvious reasons. Some collars are made with the desirable feature of being chambered, that is containing less stuffing at this location so that there is a distinct depression. The so-called Kay collars, those made in one piece and completely closed at the top, are far less likely to produce the injury. Key collars, however, are essentially of light weight as they cannot be made heavy and durable enough for heavy draft work without being cumbersome to handle. Their use is advocated whenever feasible. The injury is more common with horses working in double harness than with those working singly. In double hitches the weight of the wagon tongue through the chains exerts a pulling down effect on the collar in going down grade and in stopping the vehicle. Shortening the pole-chains to the extent of lifting the tongue is also a contributing factor in the production of sore necks.

(2) Injuries to the sides of the neck just below the one described occur most frequently in thick necked horses. Upon examination the collar will be found too tight or the hames too straight. In either case the effect is the same, the part is pinched. If the collar is at fault, some of the stuffing should be removed. If this is not sufficient to overcome the difficulty the collar may be widened by stretching. It must be remembered, however, before recourse is had to this procedure, that widening a collar inevitably shortens it. Thus, while we may relieve the neck from continued injury by this method, we may at the same time so alter the shape of the collar as to produce equally serious consequences at another part of the collar bed. Unless the amount of stretching required is limited the collar had better be discarded and a properly fitted one procured. Finally, alterations to the collar are of no avail if the hames do not have the proper curvature.

(3) The part of the collar bed above the shoulder joint and under the point where the hames are attached to the collar is another common site of injury. When injuries occur in this location the collar will nearly always be found to be too wide so that there is considerable oscillation from side to side. The remedy for this condition is to increase the bulk of the collar body at this point by additional stuffing until lateral movement is practically eliminated. The injury not infrequently appears to be so far behind the collar when the animal is at rest as to lead one to question whether its occurrence may not be due to another cause. In such cases the collar is generally very much too wide and the amount of lateral movement present may be as much as four or five inches. If the test described in (5) above under "Fitting of the Collar" be applied, the collar will be found to touch the injury when worked over in its direction.

(5) A collar which is either too tight or too loose at the lower third of the neck may produce injury to the skin over quite a considerable area. The damage occurs anterior to the shoulder joint and often extends above and below so that the affected surface may be as much as five inches in length. The cause is invariably friction and an inspection of the collar will indicate which of the two mentioned faults is present in a particular case. If the collar be found too wide, a felt pad worn under the body may be sufficient to correct the condition; if not, restufling or narrowing and shortening the collar is the only alternative.

(5) The injuries produced by collars not containing enough stuffing or those in which the body has become badly flattened through compression in draft are found behind and usually slightly above the shoulder joint. Such collars are generally quite old and the flattening of the body allows the raw edge of the afterwale to project beyond it and cut into the skin. This condition may be readily detected if the examination is conducted at a time when the animal is engaged in draft. At other times it is not so apparent and may be overlooked. The corrective is re-stuffing of the collar but generally its age is such as not to warrant the expense. Cutting off the edge of the afterwale may be resorted to as an expedient in an emergency.

ALTERATIONS TO COLLARS

According to the nature of the changes desired, alterations to the collar may be regarded as temporary and permanent. The first class includes such methods as chambering the body and placing small pads beneath the collar to protect a sore place. Pads are seldom satisfactory, as they are often productive of more

harm than good. Instead of the whole weight in draft being distributed evenly over the collar bed it falls entirely upon the pads and the damage occasioned is generally worse than the injury they are intended to relieve. The only type of pad which should be used under a collar is one which entirely covers the under surface of its body and it must be securely attached to the collar by means of straps with buckles or clamps to prevent it from sliding out from under the collar and causing uneven pressure on the shoulders. Any temporary method of tightening the collar other than by the use of a full pad is to be severely condemned.

The shortening, lengthening and re-stuffing of collars are permanent alterations and should only be attempted by an expert. Alterations to a collar should never be made without the saddler seeing it on the horse and examining it in position. Neither should the alteration be completed until assurance is obtained that the fit is correct by trying it on the animal in a semi-finished state.

New collars are firm and stiff and they require a certain amount of wear before becoming properly adjusted to the shape of the collar bed. The difficulty may be largely overcome by immersing it in water for a couple of hours and then placing it on the horse. The collar may then be adjusted snugly to the shoulders and neck with the hames strap. The horse should be worked moderately and steadily throughout the day. Soaking the collar in this way serves to soften it and it will more readily adjust itself to every inequality of the shoulders and neck. Poorly fitting old collars may often be treated to advantage in the same manner.

In conclusion it may be emphasized that most collar injuries result from friction and their cure and prevention depends upon eliminating oscillatory movement of the collar.

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CONCERNING THE SUGAR CANE ROOT PARASITE, AEGINETIA INDICA.[1]

By FRANK P. MCWHORTER
Of the Department of Plant Pathology

WITH ONE PLATE

In those regions of the Islands where sugar cane is grown, the root parasite, *Aeginetia indica* L., is yearly becoming a more serious pest. It has been reported, described, and figured several times. The purpose of this paper is to call attention to the work of Kusano[2] who, in 1908, published an excellent paper describing the plant's life history. Kusano's careful study of the plant has yielded data that may be of use in controlling the pest here in the Islands where it seriously damages sugar cane. It damages the cane, its host, by greatly reducing the sugar content and causing the formation of substances that render the cane unfit for milling.

Aeginetia indica is an Indo-Malayan member of the broom-rape family. It closely resembles its western cousin, *Orobanche*, which does serious damage in Europe. Unfortunately *Aeginetia indica* is not restricted to any particular host. Kusano showed that it may be grown successfully on a large number of monocot hosts. In the field, it is found on a number of wild grasses and on many cultivated plants such as upland rice, (*Oryza sativa* L.), maize (*Zea Mays* L.), and sugar cane (*Saccharum officinarum* L.). In the Philippines it seems to be more abundant on sugar cane than on any of its other hosts. It has never been reported on any dicot. It is interesting to note that the European *Orobanche* (*Orobanche europaea*) has never been reported on any monocot.

A single plant consists of several white or pink branches arising from a common point of attachment on the host root. It has neither roots nor chlorophyll of its own; hence it must get all of its food from its host. Each branch produces several flowers and each flower produces thousands of extremely small seeds. Two hundred thousand seeds for a medium sized plant is a conservative estimate The flowers have often been mistaken for flowers of the cane itself; they are no more part of the cane than a flea is part of a dog. Fortunately the plants are seldom more than fifty centimeters in height. Their low-growing habit and the fact that they fruit when the cane is large and beginning to mature, hinder the distribution of the tiny seeds by wind and rain. They are often, thereby, forced to distribute their seeds over a relatively small region, which may account for the great abundance of the plant in restricted areas in large fields.

LIFE HISTORY

According to Kusano, the tiny seeds lie in the soil for months waiting for the rootlets of some holophytic plant to come near enough to furnish the stimulus necessary for their germination.[3] They cannot germinate until actual contact with a suitable host is attained. The roots of the wrong host will

[1] Experiment Station Contribution No 96

[2] Kusano, S. Further studies on *Aeginetia indica* Bulletin of the College of Agriculture, Tokyo Imperial University 8: 59-79 1908

[3] Dr N. B. Mendiola and the writer performed some experiments here at the College of Agriculture, that indicate that the seeds must after-ripen for a period of a few weeks before they will germinate

make the seeds start germinating but they cannot complete germination until the roots of a suitable host find them. The seedlings are so small that they are invisible to the naked eye during the first stages of germination. After a few days, a small tubercle one to two millimeters in diameter is formed on the host root. The tubercle grows slowly for a while; it is then developing a very efficient haustorium that enables the parasite to form direct connections with the food and water streams of the host. When the haustorial connection has become thoroughly established, the tubercle develops rapidly and sends up a number of branches. The branches have flowers formed on them before they emerge from the ground. The entire plant mass is produced from the food of its host.

Kusano showed that the seeds of *Aeginetia* are viable for less than two years, even when the seeds are kept in a dry condition. Their viability must be considerably less in the sugar cane fields where they are exposed to moist conditions. They contain a very high fat content, which, together with their thick walled seed-coats, may serve to prevent their absorbing water until a proper host furnishes the growth stimulus. Kusano also showed, as before stated, that the host apparently must be a monocot, and that the seeds will not germinate without the stimulus of a host root.

CONTROL MEASURES

On a basis of Kusano's excellent laboratory studies, and the author's field observations in Laguna, the following control measures are recommended:

1. That as many as possible of the attacked cane plants, together with the attached parasites, be dug up and burned, thereby preventing seed formation and distribution. Since the parasite first occurs very locally in the field, this procedure may often be very completely carried out.
2. That badly infected fields (generally ratt on stands) be ploughed deeply and then planted to some dicot crop such as mungo (*Phaseolus radiatus* L.), jack bean (*Canavalia gladiata* [Jacq.] DC.), camote (*Ipomoea batatas* [L.] Poir.), yams (*Dioscorea* spp.), or cassava (*Manihot utilissima* Pohl.). In case a very large area is infested, it would be practical to follow the cane with some leguminous cover crop, which, when turned under, will serve as a fertilizer. Wait at least eighteen months before replanting to cane. Do not follow the cane with corn or rice.
3. That it will not be feasible to attempt to develop an *Aeginetia* resistant cane; the parasite is not even confined to the genus *Saccharum*, so it will not be likely to respond to varietal host differences.

ILLUSTRATION

PLATE I

Aeginetia on Sugar Cane

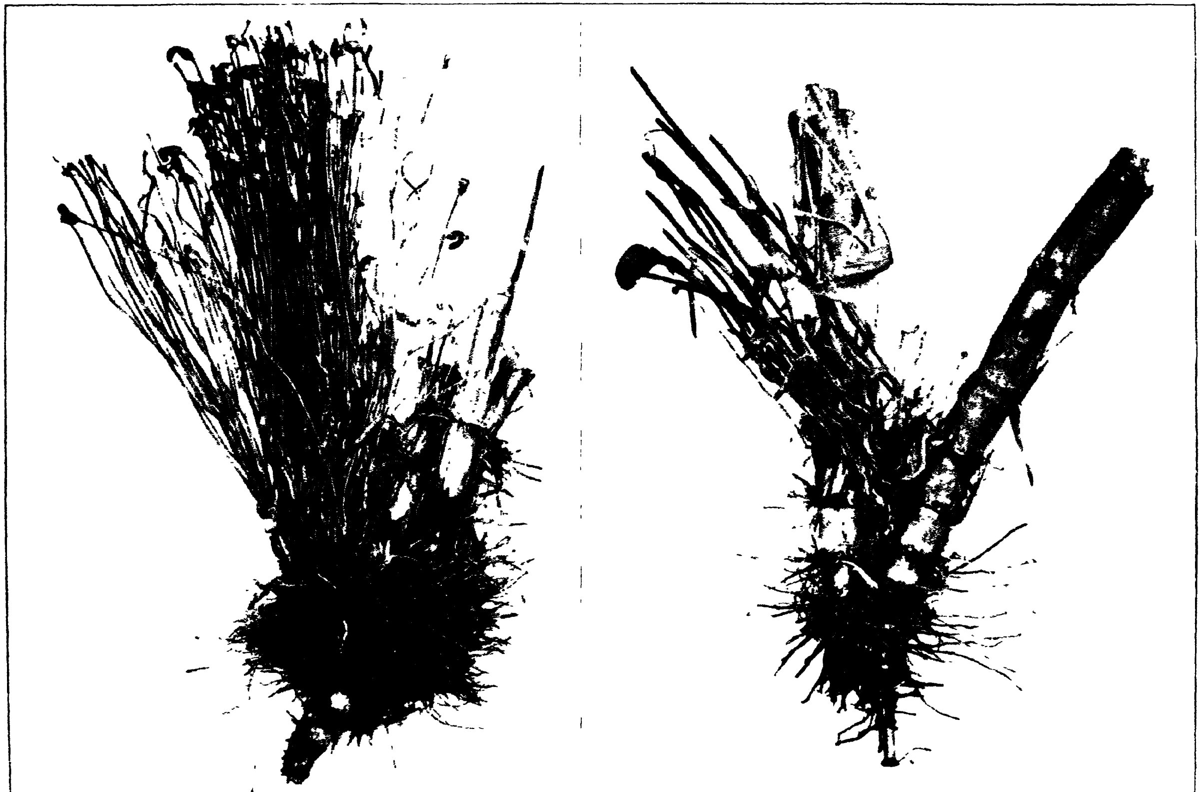

PLATE I AEGINETIA ON SUGAR CANE

DISTRIBUTION OF VITAMINS IN INVESTIGATED FOOD MATERIALS

The table herewith presented is in supplement to ROXAS, MANUEL L. The modern conception of nutrition and some of our food problems, *Philippine Agriculturist X: 447-465.* It is taken from SHERMAN, H. B. and SMITH S. L. The vitamines. 273 pp., New York, 1922.

+	indicates that the food contains the vitamin.
+ +	indicates that the food is a good source of the vitamin.
+ + +	indicates that the food is an excellent source of the vitamin.
—	indicates that the food contains no appreciable amount of the vitamin.
?	indicates doubt as to presence or relative amount.
@	indicates that evidence is lacking or appears insufficient.

Source	*Vitamin A.*	*Vitamin B.*	*Vitamin C.*
GRAIN PRODUCTS			
Barley, whole	+	+ +	—
Bread, white (water)	?	+	—
Bread, white (milk)	+	+	?
Bread, whole wheat (water)	+	+ +	?
Bread, whole wheat (milk)	+ +	+ +	?
Corn (maize), white	—	+ +	—
Corn (maize), yellow	+	+ +	—
Cottonseed meal	+	+ +	@
Flour, white	—	+	—
Grains, sprouted	+	+ + ?	+ +
Malt, green	+	+ + ?	+ +
Millet	+ +	+ +	@
Oats	+	+ +	—
Rice, polished	—	—	—
Rice, whole grain	+	+ +	—
Rye, whole	+	+ +	—
Wheat embryo	+ +	+ + ?	—
endosperm	—	+	—
middlings, commercial	@	+ + +	—
bran	+	+ + ?	—
whole	+	+ +	—
SUGAR AND STARCHES			
Glucose	—	—	—
Honey	—	+	—
Starch	—	—	—
Sugar	—	—	—
FATS AND OILS			
Beef fat	+	—	—
Butter	+ + +	—	—
Coconut oil	—	—	—
Codliver oil	+ + +	— ?	—
Corn oil	+ ?	—	—
Cottonseed oil	+ ?	—	—
Cottonseed oil	+ ?	—	—

Source	*Vitamin A.*	*Vitamin B.*	*Vitamin C.*
FATS AND OILS			
Horse fat	+	—	—
Lard	+ ?	—	—
Linseed oil	—	—	—
Margarine, nut	—	—	—
Mutton fat	+	—	—
Olive oil	—	—	—
Oleo oil	+	—	—
Orange peel oil	+ +	@	@
Palm oil	+	—	—
Peanut oil	—	—	—
Pig kidney fat	+ +	—	—
Whale oil	+ +	@	—
MEATS AND FISH			
Brains	+	+ +	+ ?
Fish, lean	—	+	@
fat	+	+	@
Heart	+	+	+ ?
Kidney	+ +	+ +	+ ?
Liver	+ +	+ +	+
Meat (muscle)	— to +	+ ?	+ ?
Meat extract	—	— ?	—
Meat, canned	—	slight	—
Roe, fish	+	+ +	+ ?
Sweetbreads	+	+	@
FRUITS			
Apples	+	+	+
Bananas	+ ?	+ ?	+
Cloudberries	@	@	+ + +
Cloudberries (canned)	@	@	+ + +
Cocum (dried)	@	@	+
Grape juice	@	+	+
Grapefruit	@	+ +	+ +
Lemon juice	@	+ +	+ + +
juice dried	@	+ +	+ + +
Limes	@	+	+
Mango	@	@	+
Mulberries	@	@	+
Orange juice	+	+ +	+ + +
peel	+	+	+ +
Pears	@	+	@
Prunes	@	+	—
Raspberries	@	@	+ + +
Raspberries (canned)	@	@	+ + +
Tamarind, dried	@	@	+
Tomatoes, raw	+ +	+ + +	+ + +
canned	+ +	+ + +	+ + +
dried	+ +	+ + +	+ +
VEGETABLES			
Alfalfa	+ + +	+ + +	@
Beans, kidney	@	+ + +	@
navy	@	+ + +	—
soy	+	+ + +	—
sprouted	@	@	+ +
string, fresh	+ +	+ +	+ +

Source	*Vitamin A.*	*Vitamin B.*	*Vitamin C.*
VEGETABLES			
Beets	@	+	@
Cabbage, fresh raw	+	+ + +	+ + +
cooked	+	+ +	+ +
dried	+	+ +	+
green	+ +	+ +	+ + +
Carrots, fresh raw	+ +	+ +	+ +
cooked	+ +	+	+
Cauliflower	+	+ +	+
Celery	@	+	@
Cress	@	@	+
Chard	+ +	+	@
Cucumber	@	+	@
Dandelion greens	+ +	+ +	+
Dasheens	— ?	+	+
Eggplant (dried)	@	+ +	@
Endive	+	@	+
Legumes, sprouted	@	@	+ +
Lettuce	+ +	+ +	+ + +
Onions	@	+ +	+ +
Parsnips	— ?	+ +	@
Peas	+ +	+ +	+ ?
Peas, sprouted	@	@	+ +
Potatoes, sweet	+ +	+	@
white raw	+	+ +	+ +
white boiled (15 minutes)	@	+ +	+ +
white boiled (1 hour)	@	+ +	+
white, baked	@	+ +	+
Radish	@	+	@
Rhubarb	@	@	+
Rutabaga	— ?	+ +	+ + + ?
Sauerkraut	@	@	— ?
Spinach, fresh	+ + +	+ + +	@
dried	+ + +	+ +	@
Squash, Hubbard	+ +	@	@
Swede	@	+ +	+ + + ?
Turnips	— ?	+ +	@
NUTS			
Almonds	+	+	@
Brazil nuts	— ?	+ +	@
Chestnuts	@	+	@
Coconut	+	+	@
Coconut press cake	+	+	@
Filberts	@	+ +	@
Hickory nuts	@	+ +	@
Peanuts	+	+ +	@
Pecans	@	+	@
Pine nuts	+	+	@
Walnuts, black	@	+ +	@
Walnuts, English	@	+ +	@
MILK			
Milk	+ + +	+ +	+ variable
condensed	+ + +	+ +	+ variable
evaporated	+ + +	+ +	— ?
dried, whole	+ + +	+ +	+ variable
dried, skim	+	+ +	+ variable
Skimmed milk	+	+ +	+ variable

Source	*Vitamin A.*	*Vitamin B.*	*Vitamin C.*
DAIRY PRODUCTS			
Butter	+ + +	—	—
Buttermilk	+	+ +	+ variable
Cream	+ + +	+ +	+ variable
Cheese	+ +	@	@
Cottage cheese	+	@	@
EGGS			
Eggs	+ +	+	+ ?
Eggs, white	@	@	@
Eggs, yolk	+ + +	+	@
YEAST			
Yeast	—	+ + +	—
Yeast extract	—	+ + +	—

ABSTRACT

La dyspepsie parasitaire et le complexus symptomatique lié au parasitisme gastro-intestinal.[1] Diagnostic et traitement. M. le DR. ROGER, (*Journal de Médecine Vétérinaire et de Zootechnie* 68: *73-85; 153-165.*)—The author discusses gastro-intestinal parasitism of equines from the clinician's viewpoint and states that our knowledge of the clinical phase of that morbid condition is far behind our knowledge of its zoological phase. The term parasitic dyspepsia is employed to designate the symptom complex produced by parasites living in digestive tract of equines, including such forms as bots (larvae of species of *Gastrophilus*), ascarids (*Ascaris equorum*), palisade worms (species of *Sclerostomum*), species of *Cylicostomum, Oxyuris*, and other nematodes of common occurrence in the digestive tract of horses.

These parasites produce a variety of symptoms the most striking disturbances, involving the digestive, circulatory, respiratory and nervous systems.

The animal's appetite may be increased or diminished and is frequently perverted. Nausea, yawning, flatulency, constipation, diarrhea, entero-colitis, colic, straining of the bowels, mucoid stools, prolapse of rectum, and anal pruritis are the most marked disturbances of the digestive system. The author also states that the condition known as "lampas," namely a swelling of the mucous membrane that covers the hard palate and projects in a ridge immediately behind the upper incisors, is a manifestation of intestinal parasitism in horses.

Disturbances in the circulatory system include a diminution in the number of red blood corpuscles (oligocythemia), a diminution in the volume of the red clot as compared to the volume of the serum and pale mucous membranes. The author states further that horses that are anemic despite the fact that they are well fed in proportion to the work that they do should be considered infested with gastro-intestinal parasites in the absence of other anemia producing factors, such as aortitis, leukemia, Bright's disease, rheumatism or convalescence from an infectious disease. Young horses that are anemic are in nine cases out of ten infested with parasites. In older horses, however, anemia may be due to organic troubles, such as diseases of the digestive and respiratory systems, of the kidneys, auto-intoxication, oxalemia, etc. The leucocyte count presents considerable variation involving an increase in the polymorphynuclears and eosinophiles and a diminution in the lymphocytes and mononuclears. Following treatment the polymorphynuclears diminish and the mononuclears increase, a phenomenon that has considerable prognostic value. Oedema of the eyelids and of the limbs, and a functional venous pulse are also frequent.

The respiratory disturbances are breathlessness and a cough. The latter is sometimes of gastric origin but is more often pulmonary (pulmonary habronemiasis).

[1] Gastro-intestinal parasitism is of very common occurrence in horses in the Philippine Islands. So far as is known, bot-fly larvae have not been encountered in native horses and it is very probable that these parasites do not occur in the Philippines. The other species of parasites mentioned in this paper are very abundant, however, and are undoubtedly responsible for many pathological conditions in equines.

Nervous troubles, such as vertigo, epilepsy, vascular spasms and psychic disturbances, which appear suddenly, and which subside following the expulsion of the parasites are common.

In addition to the symptoms already described, there are general disturbances, such as lowering of vitality, flaccid muscles, emaciation, fever while the animal is working, renal and hepatic insufficiency, sterility, and even abortion.

The presence of intestinal worms may be diagnosed with the aid of the microscope but the presence of Gastrophilus larvae can be detected only by the presence of gastric symptoms. Carbon bisulphide and oil of turpentine gave very satisfactory results as medicinal agents. Carbon bisulphide was found effective against parasites in the upper part of the digestive tract, namely, bots, ascarids and habronemas (stomach worms). The drug was administered in castor oil, morning and evening, the dose being 12½ grams of carbon bisulphide in 100 gms. of castor oil, making a total dose of 25 grams or 20 cc. of carbon bisulphide. This dose was sufficient for horses weighing 350 to 400 kilograms. The larvae of Gastrophilus begin to leave the host within 24 to 48 hours following this treatment and continue their exodus for a few days. Within 8 days after treatment practically all larvae have been expelled. Carbon bisulphide was found to be potent against all species of Gastrophilus and equally potent against ascarids.

Against intestinal parasites oil of turpentine was found to be an excellent remedy, the dose being 50 to 60 grams of turpentine in 500 grams of castor oil. It is seldom necessary to administer a second dose of this drug, as the first dose usually expels nearly all intestinal parasites.

In order to enable animals to recover from the effects of parasitism, arsenic, arsenious acid, sodium cacodylate and other drugs are recommended following anthelminthic medication.

The author states that just as in the practice of human medicine chronic ailments of unknown etiology always arouse a suspicion of syphilis, tuberculosis or rheumatism so in veterinary medicine, similar conditions warrant a suspicion of parasitism.

He recommends that horses be treated twice a year, namely after the rainy season, and early in autumn.

Abstracted by B. Schwartz

COLLEGE AND ALUMNI NOTES

RESOLUTIONS OF THE STUDENT BODY

Whereas, on July 17, 1921, the Student Body of the College of Agriculture was deprived of the companionship of Mr. Vitaliano Rodriguez Ylanan by his untimely death, and

Whereas, in his passing we have lost an ardent co-student and his valuable help as a member of the Student Body, and

Whereas, in him we have lost a promising student in the prime of his young manhood, be it therefore

Resolved, that we, members of the Student Body, extend our sincere sympathy and condolence to the bereaved parents and relatives, joining in their grief, and be it further

Resolved, that this resolution be spread in the minutes of the Student Body, and be it further

Resolved, that a copy of these resolutions be sent to the bereaved family of the deceased; and that copies thereof be sent to the Philippine Agriculturist and the Philippine Collegian for publication.

Dated at the College of Agriculture, University of the Philippines, Los Baños, this Seventh Day of August, in the Year of our Lord, Nineteen Hundred and Twenty-two.

BY THE COMMITTEE:
Alexander Gordon
Gregorio Antenor-Cruz
Gonzalo H. Salazar

RESOLUTIONS OF THE COLLEGE OF AGRICULTURE ALUMNI ASSOCIATION

Whereas, on August 19, 1922, the death of Rufino Custodio Cuitiong, B. Agr. '22, of Tanay, Rizal, deprived us of the companionship of a co-alumnus;

Whereas, this untimely demise of Rufino Custodio Cuitiong means a loss of leadership for the fostering of agricultural science and education in the Philippines;

Whereas, the friendly character, pleasing personality, and helpful disposition of said Rufino Custodio Cuitiong have always commanded the sympathy, admiration and friendship of those who have associated with him, now therefore be it

Resolved, that we, the members of the College of Agriculture Alumni Association, express, as we do hereby express, our deep sorrow for this lamentable death of a *friend* and a *leader* in our chosen field of Agriculture; be it further

Resolved, that we extend our heartfelt sympathy to the bereaved parents and relatives of the deceased; and be it further

Resolved, that a copy of these resolutions be spread upon the minutes of the Association, and that a copy thereof be sent to the parents of the late Rufino Custodio Cuitiong, and that the *Philippine Agriculturist* and the *Philippine Farmer* be requested to publish the same.

Dated at the College of Agriculture, University of the Philippines, Los Baños, Laguna, this Nineteenth Day of September, in the year of One Lord Nineteen Hundred and Twenty-two.

THE COMMITTEE ON RESOLUTIONS:

Rafael Piguing
Rafael B. Espino
Elias M. Caray

The Philippine Agriculturist

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EDITORIAL

THE NECESSITY FOR STANDARDS

What is Science? To the average man the word conveys a confused idea of abstruse and impractical subjects—archaeology, palaentology, entomology,—the pursuits of bespectacled old men with long hair who mutter long Latin names to themselves. He thinks of a scientist as an absent-minded old professor walking down the street with one foot on the footpath and one in the gutter and wondering all the time why he has become suddenly lame, or boiling his watch in a saucepan and timing the process by the egg which he holds in his hand. The misconception of the real nature of Science and scientific investigation dates back to the early days of modern methods. The ancients speculated on the meaning of things in general, and with surprising frequency they hit on the truth. Occasionally they would arrive at a conclusion through experiment, and it is strange that the success of such a method of investigation should not have resulted in its more frequent use. Archimedes was a true scientist. His most famous experiment, it is true, was an accident, *but he was able to apply his accidentally gained information.* How many men before Archimedes must have discovered his Principle, but lacking his powers of application, missed their opportunity to make a deathless name!

In the middle ages the methods of investigators became so corrupted by occult practices that new discoveries were discouraged and the investigators persecuted. Witches and warlocks practiced their dark arts under the constant fear of Church persecution. The Church, unwilling to discard her ancient cloak of superstition constantly stamped out the smouldering sparks of the new knowledge.

And so Science became to the popular mind a mysterious sort of a study removed from everyday life, though sometimes furnishing magical results all the more wonderful because of the ignorance of those who did not understand the underlying principles on which they were founded. Even at our present relatively advanced stage the general idea is still very much the same as it was in the middle ages, though the intolerant persecution of investigation has almost abated. We still have in our midst, however, those who would suppress the teaching of things they cannot understand, such as Evolution. Anti-vivisectionists and anti-vaccinationists continue to obstruct the onward march of progress, and people will still consult herbalists and chiropracticians instead of doctors. They have not yet realized that Science is classification and co-ordination of facts—nothing

more, nothing less. Modern scientific knowledge is the result of a slow accumulation of data. Fragment by fragment the structure has been built. Mistakes have been made and will always be made, and when they are discovered, the builders must go back and rectify them. There is the outstanding difference between the methods of the magician of the middle ages and those of the modern scientist. One tried to arrive at his result in one groping step. The other investigates his materials and reasons out what results he may expect. Sometimes his results are *not* what he expects, but he has the foundations which will enable him either to have a good idea of what will happen, or else to understand it when it does happen and be able to use it as a step towards further knowledge.

The fundamental idea of Science being the classification and co-ordination of knowledge it is obvious that standards must be adopted. Common usage in different countries has resulted in the adoption of standards within those countries, standards altogether different from those used in neighboring countries. For international use either a system of exchange must be adopted, or an arbitrary universal standard must be fixed. Perhaps the chief varying factor is language. No language is perfect. The evolution of a tongue means that all sorts of irregularities must creep in. Constant borrowing from foreign sources widens the scope of a language and improves it as a means of expression, but, at the same time, it makes it less and less amenable to set grammatical rules. A universal tongue should be capable of adapting itself to new needs as they may arise,—of being able to interpolate new words without creating exceptions in its pronunciation or declension—and also be free from liability to change in its essential nature. All languages are subject to slow change, a fact that is brought home forcibly to those who try to read Rabelais in the original French or who read Chaucer for the first time. If a universal language were adopted as a standard the same trouble as has happened in America would be liable to develop. Deviations would have to be made to suit new conditions, and in time a dialectal entity would come into being.

None of the existing languages are able to resist this tendency to break up into dialects. English, French, Spanish, all have the same weakness. Their rules are not sufficiently stringent. We must fall back on one of two alternatives. Either a dead language must be adopted or a new and artificial language with hard and fast rules must become the standard. Latin possesses certain advantages, but lacks the simplicity of modern tongues. Long years of study are necessary for its mastery. Then for modern use new words must be coined, and it is no longer Latin; it has become a new language founded on Latin grammar.

Realizing the difficulties of adapting any living or dead language to the needs of everyone. Dr. L. L. Zamenhof devised Esperanto, a beautiful tongue which combines the advantages of the various European languages without their disadvantages. The pronunciation and grammar are fixed, and the flexibility of word-formation is such that delicate shades of meaning may be expressed in a single word where in another language a whole sentence would be required.

Everyone likes his own dog best, and everyone his native language best. On that account the adoption of Esperanto will probably never be universal. Like the brotherhood of man, it is an ideal. It would make an excellent scientific medium, one easily intelligible and capable of conveying ideas quickly and accurately.

French is the language of diplomacy. Science has no *lingua franca*, but to a certain extent standardization has been established. The first and most obvious point is in the systems of mensuration and of weighing, where the metric system has been adopted, though not as universally as it should be. The binomial system of nomenclature which was adopted by Linnaeus (it was used to a certain extent before his time) was an important step in the standardization of botanical and zoological names. The language chosen was Latin and except for the confusion of genders, it is an admirable one for the purpose. The advantage of the Linnaean system is its universal nature. The fruit that an Englishman calls "apple" is "pomme" to the Frenchman, "yabloko" to the Russian, "apfel" to the German, but *Pyrus malus* is the name which is understood by them all. The drawbacks of universal biological nomenclature, however, are not to be overlooked. Once an organism has received some particularly cumbersome or inappropriate name, it is branded for ever. As the late O. Khayyam said:

> "The Moving Finger writes; and, having writ,
> Moves on: nor all thy Piety nor Wit
> Shall lure it back to cancel half a Line
> Nor all thy Tears wash out a Word of it."

Then there is the trouble which arises when two men name the same animal or plant independently. The rules are clear cut on the point. The first name given, whether it be the more appropriate or not, survives. The other becomes a synonym. The question of synonyms becomes a penchant with some authors. The name is all that interests them; the organism receives its name, and then their interest swerves to some other doubtfully labelled specimen,—another orgy of name-juggling. "Tomorrow to fresh fields and pastures new."

With the multitude of scientific journals publishing taxonomic work it is necessary to have some standard institution as a permanent authority to decide all questions of debatable character as far as nomenclature is concerned. In botany, there exists such an institution in the Royal Botanic Gardens at Kew in England. Children will always want to break away from home when they are big enough to brave the world alone, and the same is true with nations and with smaller institutions. No herbarium in the world can compare with that of Kew, but a number are sufficiently strong now to attempt to stand alone and formulate their own standards. This is a deplorable state of affairs. If we have a standard, we want one standard only, whether it be Greenwich time or Kew's ruling on nomenclature.

D. A. Herbert,
Professor of Plant Physiology.

THE NATURE OF THE ORGANISM FOUND IN THE FIJI GALLS OF SUGAR CANE

By Frank P. McWhorter[1]

Of the Department of Plant Pathology

TWO PLATES AND TWO TEXT FIGURES

Although Fiji disease is a now well known and widespread disease of sugar cane, its cause has never been demonstrated. Lyon (1), in 1910, called attention to "foreign plasmic bodies" present in tissues of the galls which, as he suggests, are probably the cause of Fiji disease. Lyon's first paper on the nature of these "plasmic bodies" was based on a study of formalin material; his later papers are based on a study of fresh material and carefully fixed material. In 1921 he published a more detailed account in a paper dealing with the general characters of Fiji disease (2). The data presented in the 1921 paper is based partly on a study of material collected and sectioned by Mr. D. S. North who collected material in the Fiji Islands. He states that the study of this material "strengthened his opinion that the foreign bodies were individuals of a parasitic organism, but showed that the structure of this organism did not correspond to that of any known parasite, and he (Lyon) was, and still is, at a loss to know just where in the natural system this organism should be classified." He states also, that in an unpublished manuscript, he proposed the name *Northiella sacchari* for the organism, and "that in developing galls the individuals have been observed to divide simultaneously with the nuclei which they accompany". This last is a very significant statement. His conclusion that the data then available is insufficient to locate the organism, is certainly correct. On account of the seriousness of the disease here in the Laguna region, I have been forced to investigate its cause. After weeks of study I felt like Mr. Lyon, that I needed something to strengthen my "opinion that the foreign bodies were individuals of a parasitic organism." Finally, after numerous unsuccessful attempts, I have been able to culture the organism and thereby prove that it is a distinct being, and not some morbid cytoplasmic structure developed by unseen causes.

For a good general description of Fiji diseased plants the reader is referred to a paper by Reinking (3).

Fiji disease is not the only cane disease that has been attributed to plasmodial organisms. Matz (4, 5), working in Porto Rico, has described a plasmodial body present in many cells of cane showing yellow stripe disease; i. e., sugar cane mosaic. Frequently, in the parenchymatous tissues of leaves and stems of Fiji diseased cane I have observed cell contents that closely agree with the structures that he described as plasmodia. Careful examination with polariscopic and simple microchemical tests has convinced me that, in the case of Fiji diseased cane, such cell contents are carbohydrate waste products produced by and not the cause of the disease. Unfortunately the illustrations, that accompany the article alluded to, do not show the nuclear conditions of the cells wherein the

[1] Experiment Station Record No. 97.

plasmodia are forming. However, the author figures yellowed nuclei with thickened walls and calls attention to the fact that they simulate plasmal bodies. Such nuclei are abundant in the dying parts of Fiji diseased cane. He describes the suspicious plasmal content as "more or less hardened or compact, densely but finely granulated and slightly browned plasma". When pieces of diseased cane were stored for several days the plasmal masses were observed to have undergone certain changes. The granules became visibly more distinct and exhibited what he describes as a "rotary movement". He is not at all certain that this plasmal mass is the cause of the disease. He states: "furthermore this substance, resembling a *Plasmodium*, in some of the interior cells was found to be constantly associated with yellow-striped cane in an advanced stage of disease". That it really is a plasmodium remains to be proved.

Another plasmodial disease of cane is a vascular one. It was discovered and described by Matz (6). The original description of the causal organism is as follows:[2]

Plasmodiophora vascularum Matz. "The spores in their advanced stage in the interior of the vessels of the fibro-vascular bundles are spherical with smooth, somewhat thick hyaline walls, evenly granulated or sometimes coarsely granulated in the interior, orange, yellow, sometimes slightly brown in color, measuring .014--.016 millimeters in diameter. Spores are embedded in a yellowish, hyaline, at length hard matrix. Plasma is composed of a mass of granular cytoplasm, later developing into individuals composed of clear, cytoplasmic variable bodies having a dense, darker, granular center."

This description would answer for certain of the stages in the life history of the organism here described. He figures the organism as occurring in both the proto and the meta-xylem strands. The cane containing this organism was stunted, and the tops were either partially or totally dry. Perhaps what Mr. Matz described was but an early Fiji infection, since the description he gives of the disease is that of Fiji disease before the formation of the galls. However, the Fiji organism, although it invades the meta-xylem is seldom seen in the protoxylem.

METHODS OF INVESTIGATION

In regard to the technique whereby the results here presented have been obtained the following may not be amiss. The making of really satisfactory paraffin sections of cane tissues, except the very young parts, involves the cutting of tissues that contain a great deal of silica. The technique used must be such that the tissues will either actually soften or have little chance to harden. No matter what fixative is used, the times in the higher alcohols should be very short. To show the general appearance of gall and leaf tissues, and especially cytoplasmic structures, a mixture of 6% formalin, 5% acetic acid in 50 per cent alcohol was most successful. In this fixative nuclei clear up but the plasmodia remain dark. Fleming's weaker solution for 30 minutes followed by a 1% chromo-acetic solution for 48 hours gives excellent fixation in the host nuclei but generally causes some plasmolysis. By means of this fixative I was able to demonstrate mitosis in the plasmodia. Long times in the chromo-acetic fixatives soften the tissues so that they can be cut. I tried following short fixation in chromic acid fixatives with a treatment of weak hydrofluoric acid but the cell contents were

[2] In the original description, the genus is spelled Plasmdiophora instead of Plasmodiophora; I presume it must be a typographical error.

mutilated. The plasmodial structures show up well in material fixed in a hot saturated solution of bichloride of mercury; Erlich's haematoxylin gave beautiful preparations after this fixative. Since many stages of the organism are less than a micron in diameter and the mature spores (cysts) are seldom more than seven microns in diameter little can be learned about their finer details with sections more than five microns in thickness. Unfortunately, the climate here in the Los Baños region is so constantly warm and moist that I have found it impossible to cut smooth serials thinner than three microns, and to do even this, it is necessary to use ice. Certain details of the spore wall anatomy will require one micron sections for the solving.

One of the simplest ways to clearly distinguish plasmodia from nuclei in free-hand sections is to put the sections in picro-nigrosin for one hour and then wash them and mount in water. The nuclei absorb the nigrosin much more readily than do the plasmodia. For demonstrating the finer details in paraffin sections, I have found Erlich's acid haematoxylin and Haidenhain's haematoxylin far superior to the aniline dyes including the triple combination. In studying the ameboid stages I used Giemsa's stain. When the galls are partially lignified beautiful preparations may be obtained by staining first in Erlich's and then in safranin. The plasmodia (amebae) may be sharply stained with Loefler's alkaline methylene blue, but this does not serve to differentiate the plasmodia from the nuclei.

It is very hard to get the organism to grow in drop cultures. The most successful culture I obtained was made as follows: A badly diseased plant was washed in 3 % cresol for a few seconds, then in sterile water, then cut with a sterile knife in such a way that the juice could be mashed out into a sterile petri dish. This juice was used for making hanging-drop cultures. In this particular set I prepared four slides. In the juice of each slide two or three extremely thin free-hand sections of large galls were placed. In *one* slide only the spore stage (cysts) germinated into active amebae as described below. Unfortunately the culture was contaminated and lived for only 34 hours. I first tried picking the spores out of sections with fine-drawn glass rods but have found the very thin section method preferable. My most successful cultures have been from sections whose thickness was from eight to ten microns in the gall tissue. My second most successful culture was obtained in a similar fashion but with healthy White Luzon cane juice. I have obtained numerous partially successful cultures in juice of both diseased and healthy cane. For some reason I have never obtained more than two really good cultures out of every hundred. Why, I do not know. I am certain that light is not a factor. I cannot demonstrate any definite relation to temperature. Contamination is not a factor. I have made both contaminated and pure cultures germinate.

The following procedures gave negative cultures: (1) Hanging-drop mounts in various dilute solutions of glucose. (2) Hanging-drop mounts in various dilute solutions of saccharose. (3) Hanging-drop mounts in mixtures of glucose and saccharose. (4) Hanging-drop mounts in mixtures of cane juice and sugar solutions. (5) Hanging-drop mounts in cane juice containing glands and mouth parts of certain sucking insect. This last is still being investigated.

CHARACTERISTICS OF THE ORGANISM

Before going into details regarding the life history and morphology of the organism, I wish to present the following as a summary of its characteristics.

In cane plants wherein the symptoms of Fiji disease are developing, the organism can first be demonstrated in the developing galls. In the cells of the developing galls they may be seen as irregularly shaped, lobed, ameboid bodies composed of granular protoplasm, the granules more or less equally distributed with little or no differentiation of ectoplasm. One to six such ameboid bodies are present in each cell; three is a very frequent number. These bodies differ greatly in size. One or more is generally attached to the host nucleus. The larger individuals in each cell may be seen to be pinching themselves into several smaller individuals or more frequently to be dividing into two equal halves. Stained preparations of this stage show that the bodies breaking up into smaller ones contain nuclei in a stage of chromidial fragmentation typical of amebae, and that the nucleus or nuclei are seldom or never organized within a nuclear membrane, but that when the larger individuals divide into equal halves they may do so by a primitive mitotic method. During this ameboid period the gall continues to develop, and as pointed out by Lyons divisions of the host nuclei accompany divisions of the organism. There are far more ameboid bodies than nuclei, yet every cell does not contain an ameboid body. There are, however, many more divisions of the organism than of the host nuclei, and I am certain that the divisions of the host nuclei are more frequently amitotic than mitotic. As the galls get older the bodies cease to divide. They cease to divide when the host begins to thicken the walls of the galls. Then the ameboid bodies begin to round up. All sizes round up, hence the various sizes of rounded bodies in the mature galls. Until this rounding up gets well under way, one or more of the bodies in each cell remain attached to the host nucleus. But the host nuclei may disintegrate as the organism goes into its mature stages. Seldom are mature organisms—spores—attached to nuclei. When the ameboid bodies begin to round up they begin to differentiate vacuoles in their cytoplasm. The finished structure is a hollow shell composed of highly vacuolate material, the whole constituting a firm but not brittle wall; the central portion is a clear hydro-gel. These spore bodies (cysts) are so firm that they may be readily extricated from thin sections and examined separately. When mashed with a finely drawn glass needle they quickly rebound to their original shape. These spore bodies are not formed by the cleavage of a larger plasmodial body; the larger amebae form smaller ones and either the larger or the smaller change into spores. Such bodies are not true spores; I here propose to call them *cysts*. Plants having mature galls and mature cysts exhibit dwarfing and other features of Fiji disease. In such plants it is not difficult to demonstrate various forms of the organism in other parts of the plant. Partially encysted stages may be occasionally found in the metaxylem; I have found them in the metaxylem of the roots. Such plants have very typical reduced root systems. In swollen places on these roots, which are really galls, the organism often occurs in abundance. When germinating, these cysts simply soften up their walls, generally irregularly, so that parts lobe out like a moving *Arcella*, then by

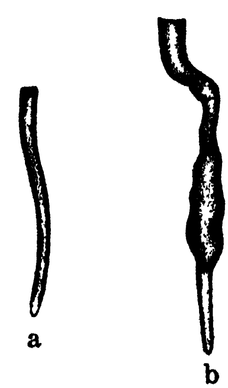

FIGURE 1.
Roots of Sugar Cane
a—Normal Root
b—Fiji gall on root

rearranging the granules composing the walls of the individuals vacuoles, change themselves into typical motile amebae. Each ameba develops one or more slowly contractile vacuoles. Both rounded and pointed pseudopodia are developed. The pointed pseudopodia which the organism develops in culture, are the nearest thing to flagellate or ciliate organs of motion that I have seen the organism exhibit. The ameboid stage in cultures shows little ectoplasmic differentiation, but in all there is a distinct, highly refractile mass present that looks and behaves like a nucleus. In cultures, the organisms that develop from the large cysts differ little from the smaller ones. However, the smaller ones, when dividing, frequently go through a peculiar trypanosome like shape. Summing this up, the cycle is ameba—cyst—ameba. During the rest of this paper I shall call them not "bodies" but amebae.

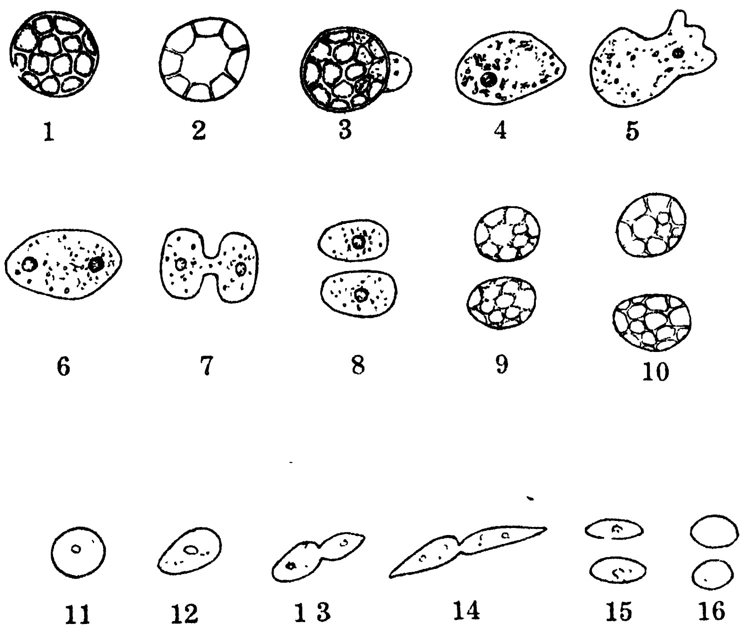

FIGURE 2.

1 Surface view of cyst 2 Optical section of cyst shown in 1 3 cyst germinating 4, 5, 6, free amebae as seen in cultures 7 ameba dividing, from culture 8, 9, 10 Encystment as seen in tissues 1-10 represent life cycle of large ameba 11-16 represent life cycle of small ameba 14 Peculiar *Trypanosome* like shape of small ameba in state of division.

Concerning the amebae in the cells the following may be of interest. In unstained sections it is difficult and often impossible to distinguish the amebae from the host nuclei. Fortunately the host nuclei frequently have plasmosomes which are plainly visible with an oil immersion lens of high N. A. even when examined in an unstained condition. The nuclei in the galls are a few microns larger than the nuclei of healthy parenchymatous cells. Metaplasmic granules and tiny starch grains present in both healthy and gall tissues will dance with a conspicuous Brownian movement suggestive of zoospores, if the sections examined are mounted in water. There is no excuse for making the mistake of calling them zoospores for such zoospore-like bodies are more abundant in healthy than in gall tissues and if either are mounted in their own juice little or no Brownian

movement will take place. Another thing that can be confusing in studying the nature of this ameboid stage, is the ability of normal cane nuclei to move around. I have frequently observed the nuclei of healthy cane parenchyme cells mounted in water or juice to change form and position and move about their alveolar contents. From nuclei the unstained amebae differ, also, in having a more even distribution of their granular content. In only one culture of the many that I have attempted of the organism at this stage have I been able to make these amebae leave the gall tissue and climb out of the host cells into the juice in which they were mounted. It took sixteen hours to accomplish this; after they came out of the cells they soon lost their activity. No movement whatever was observed after 18 hours.

The amebae present in the developing gall tissues differ but little from cultures obtained by germinating cysts in cane juice. As a matter of fact they probably do not differ in any essential, but when in the free living state provided by a culture they can be more plainly seen. I have not been able to observe any contraction of the vacuoles in the amebae when still in the host cells. In cultures the amebae are sluggishly motile but they stream their granules around with considerable rapidity. Of course the amebae in cultures tend to flatten out and spread like ordinary free-living amebae. They vary in size according to the cysts from which they have developed. In cultures I have observed only one kind of reproduction and that is what the zoologist call "simple fission" or "simple division". The body that I consider to be an organized nucleus divides first; then the whole mass divides. See figure 2. There seems to be a definite size limit; this limit is somewhere near fifteen microns. The average length is about five. One peculiarity of the amebae in cultures is their tendency to become pointed. I have never observed any tendency of these pointed pseudopodia to develop into flagella or cilia.

In stating the characteristics of the organism I outlined the method of cyst formation. Anyone who is familiar with the appearance of young *Entamoeba coli* cysts cannot help being struck with the similarity of the appearance of the two. During early stages of vacuolation the small cysts resemble certain "ring stages" developed by the *Sporozoa*. See plate II, Figure 1. Unfortunately the cysts stain so homogeneously that it is very hard to make out nuclear conditions in them. Until I have had a chance to study good one or two micron sections I do not wish to make any definite statement about this point. Some of my Erlich's haematoxylin preparations show indications of nuclear material in the larger vacuole walls; this would suggest that such cysts would on germinating break up into several individuals. I have seen no hint of such a process of reproduction in living material. Since each cyst changes into one ameba only, and since each ameba has only one nucleus, it is likely that the cysts are uninucleate. Although the wall of the cyst must contain much metaplasm I have never seen any attempt on the part of the organism to shed the wall when it germinates; the wall becomes part of the motile ameba's protoplasm.

As I have indicated, reproduction is accomplished by gemmation and simple fission. That is, the large plasmodia containing fragmented nuclei bud off on several sides into small masses, each equipped with sufficient chromatin material to enable it to develop into individual amebae. This process is hard to see in unstained material but can readily be seen in stained. When a large ameba

divides into two equal halves it may do so by promitosis as shown in Plate II, fig. 15. I have seen no indications that the large amebae are able to cleave into a mass of spores more or less alike in size and more or less loosely connected. The spore-like cysts differ greatly in size. Each cyst is formed from a single ameba, and since the amebae differ in size, so do the cysts. These cysts represent a resting, nonmotile stage in the life history of the organism and cannot be considered a method of reproduction. Each cyst changes into only one ameba.

CLASSIFICATION OF THE ORGANISM

The characters here presented as describing the organism are obviously more animal than plant. To put it in the genus *Plasmodiophora* is out of the question. Its amebae show no tendency to coalesce into a true plasmodium, the spores are large, vary in size, absorb their membranes when germinating, have no zoospore stage, and in many other ways differ entirely from this genus. They have little more resemblance to the other members of the *Plasmodiophorales*. I am forced to conclude that the organism in the Fiji galls is an ameba, parasitic not on animal tissue, as is so frequently the case with tropical amebae, but parasitic on plant tissue.

Among the *Chytridiaceae*, the fungus *Asterocystis radicis* De Wild., which causes flax root-blight, presents certain resemblances to the organism here described. This fungus lives in the dermatogen cells of the roots. Its plasmodial bodies fill all or part of their host cells. According to available descriptions, these plasmodia do not closely resemble the Fiji amebae, but the resting spores produced by the fungus might be mistaken for cysts of the Fiji organism. *Asterocystis* reproduces chiefly by means of numerous swarm spores, which fact clearly differentiates it from the Fiji organism.

Several protozoans have been described as being parasitic on algae and water plants. These parasitic Protozoans belong especially to the genera *Vampyrellidium*, *Vampyrella*, *Ectobiella*, *Enteromyxa*, and *Colpodella*. All are members of the Proteomyxa group. But the characters and life history of the Fiji amebae are simpler than and different from the members of this group. The characteristics of the amebae and their method of encystment relate them to the Lobosa group of the *Protozoa*. I can find no record of such an organism functioning as a plant pathogen. The Fiji ameba resembles *Entamoeba coli*, but the behavior of its nuclei and germination of its cysts serve to distinguish it from that genus. It cannot be classed under any of the free living genera such as *Amoeba*, *Paramoeba*, *Centrochlamys*, *Pelomyxa*, *Dactylosphaera*, etc.

Whether or not the Fiji organism should be classed with *Proteomyxa* or *Lobosa* I shall leave for some proto-zoologist to decide, but since there is apparently no existing genus wherein it may be placed I propose the following as a generic name on the basis that the organism is an ameba somewhat related to *Entamoeba*. Since Lyon did not publish his paper wherein he proposed the name *Northiella sacchari* for the "body" and does not imply any wish to so call it in his 1921 paper, I can hardly cite that name as a synonym. It looks like am ameba and lives in a plant, so I propose the generic name *Phytamoeba*, instead of *Northiella*, as the latter name has no biological significance. For species, the name *sacchari*, as suggested by Lyons, is certainly appropriate. Descriptions follow:

Phytamoeba g. nov. Small intracellular amebae capable of living in a free state. Little differentiation of ectoplasm. Pseudopodia lobose, blunt. Repro-

duction by gemmation and simple fission. Cysts form in host cell. Each cyst develops into one ameba. No zoospores.

Phytamoeba sacchari sp. nov. Small intracellular, parasitic ameba capable of living in free state. Size variable, seldom more than 12 *u*. When intracellular, pseudopodia are short, blunt, and lobose; when extracellular pseudopodia are lobose or pointed. Vacuoles present, more or less contractile in extracellular type. Nucleus organized or distributed. Cysts simple, rounded, highly vacuolate, walls smooth. Cysts germinate into amebae. Reproduction by gemmation and simple fission. No zoospores. No coalescing of amebae to form large plasmodia. Host, *Saccharum officinarum* Linn.

RELATION OF PHYTAMOEBA TO FIJI DISEASE

That Fiji disease is actually caused by *Phytamoeba sacchari* cannot be considered demonstrated until pure cultures of the organi n injected into healthy cane produce the disease under controlled conditions. At present I have a number of such experiments in progress, but it will be several months yet before the results will be available. The evidence that the organism is the cause of the disease is as follows. When the disease first appears the organism in some stage or other is always present in the developing galls. It is abundant only in the galls and cannot be demonstrated in healthy plants. In the first stages of the disease, galls are produced only on the leaves. In the later stages, the galls occasionally develop on the roots. They are abundant in the lower internodes of dying branch shoots; these internal galls (if so they may be termed) appear as grey spots up to one millimeter in diameter. In both roots and internal galls the organism is abundantly present. This means that the organism lives throughout the plant, which would account for the fact that when any node of a diseased plant is used as seed, Fiji disease results. (7, 8.)

With regard to the path of the organism through the cane plant I wish to withhold my data for future publication. I have evidence that the organism passes partly through the metaxylem and partly through certain cells of the pericycle lying between the xylem and phloem. This would help to account for the fact that the galls generally develop from that region of the pericycle.

The important question as to how the disease is carried remains undemonstrated. That it is insect borne, I have little doubt. If it is insect borne, in what condition does the organism live in the mouth or salivary glands of the insect?

SUMMARY

The "plasmodial body" present in the cells of Fiji galls is an ameba having many of the characters of *Entamoeba*. The name here proposed for the organism is *Phytamoeba sacchari*.

The organism can be cultured in cane juice. It was hoped that its ability to grow in the juices of different cane varieties could be used as a test for the susceptibility of the varieties to Fiji disease. Unfortunately the organism is so hard to grow that this method of testing proved impractiacble.

ACKNOWLEDGEMENT

The writer wishes to thank Dean C. F. Baker for many helpful suggestions regarding the preparation of the manuscript.

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ILLUSTRATIONS

PLATE I

Fig. 1.—Large parenchymatous cell from healthy leaf tissue as seen in unstained sections. For details of nucleus see fig. 2. The circular bodies are tiny starch grains floating free in the cytoplasm; similar bodies showing Brownian movement in the gall cells might be mistaken for zoospores.

Fig. 2.—Diagrammatic sketch of normal nucleus shown in fig. 1. P; plasmosome. S; vacuolar space around plasmosome. G; granules and droplets characteristics of such nuclei. apx. 5000 x.

Fig. 3.—Nucleus (dark curved body) and three cysts. Picro-nigrosin preparation.

Fig. 4.—Nucleus and two amebae. Large ameba appears to be getting ready to encyst. Unstained.

Fig. 5.—Large ameba in cell. Nucleus not shown. When in this condition it is very hard to distinguish ameboid nuclei from the *Phytamoeba* organism.

Fig. 6.—One ameba and two young cysts; nucleus not shown.

Fig. 7.—Old gall cells with thickened walls. Drawing shows surface view of mature cysts. Plasmosome plainly differentiates cell nucleus from cyst. Reticulate body in cell containing three cysts is also a nucleus. Erlich's haematoxylin preparation.

Fig. 8.—Space picture of young cyst within thickened outer gall cell.

PLATE II

Fig. 1.—Gall cell beginning to thicken. Young cyst attached to wall cell. Nucleus not shown. Note vacuoles in cyst wall and nucleus like body in center of cyst. Iron haematoxylin preparation.

Fig. 2.—Young gall cell, walls unthickened, containing nucleus in resting condition and ameba in process of gemmation. Note the well defined plasmosome in the cell nucleus Erlich's haematoxylin preparation.

Fig. 3 —This is a sketch of the ameba shown in fig. 2.

Figs. 4-9.—Optical sections of living cysts to show method of vacuolation. Surface views of cysts in condition shown in figs. 8 and 9 are illustrated in Plate 1, figs. 3 and 7. Illustrations 4 and 9 drawn by focussing central plane of cysts with short focus fluorite lens and sketching image projected with 6 x compensating eyepiece through camera.

Figs. 10 and 11.—Camera lucida drawing of germinating cysts. Surface views.

Fig. 12.—Ameba from cyst. Vacuole forming. From culture.

Fig. 13.—Ameba in peculiar pointed condition. No vacuole. From culture.

Fig. 14.—Ameba apparently about to divide. Note that two nucleus like bodies are present.

Fig. 15.—Ameba in gall cell with nucleus in late phase of division. Body next to ameba appears to be a cell nucleus disorganizing.

Fig. 16.—Ameba typical of form that develops from small cyst.

All figures, unless otherwise indicated, were drawn with 1.32 N. A. fluorite lens, and 6 x compensating eyepiece. Large Spencer camera, 160 mm. setting. Initial projection 1230 diameters; all figures reduced apx. 1/3 in making plates.

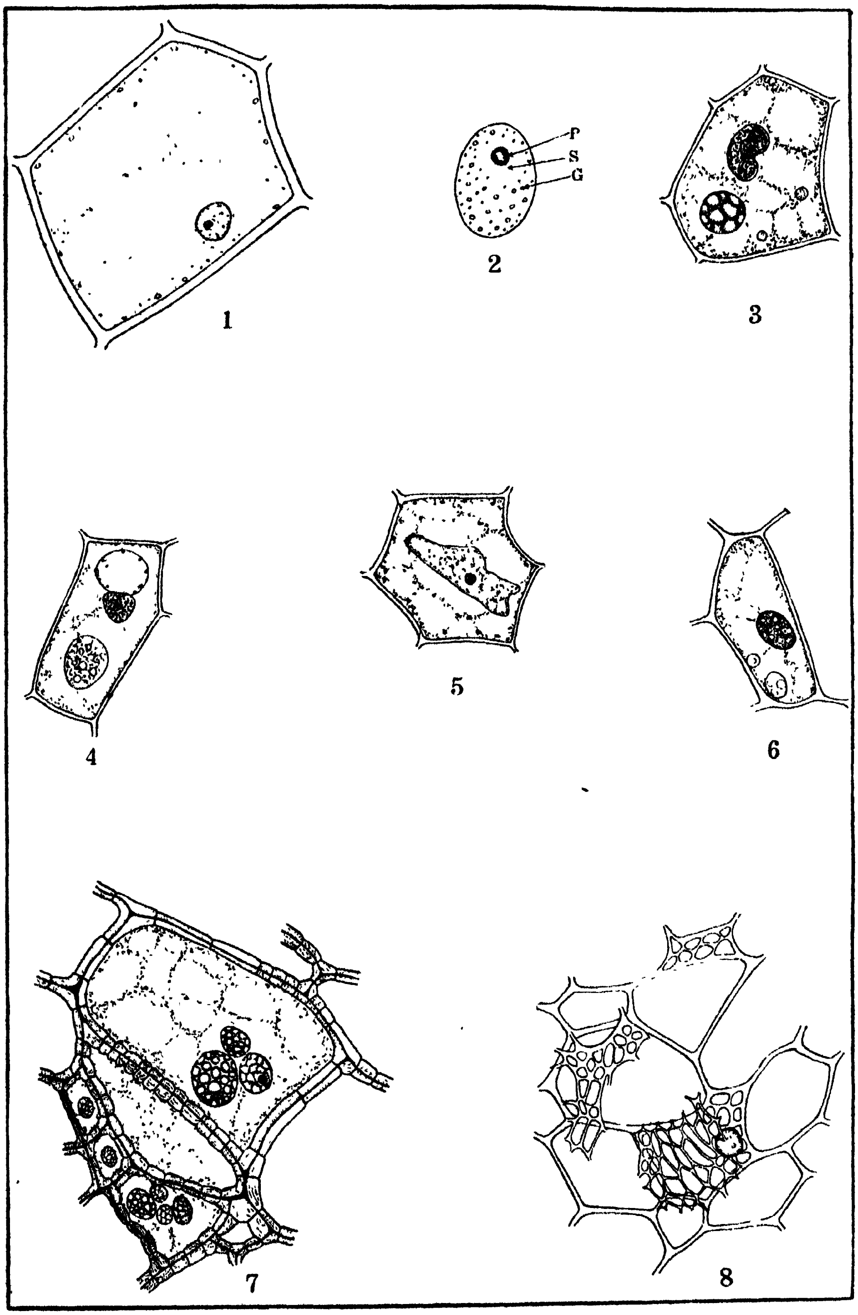

PLATE I.

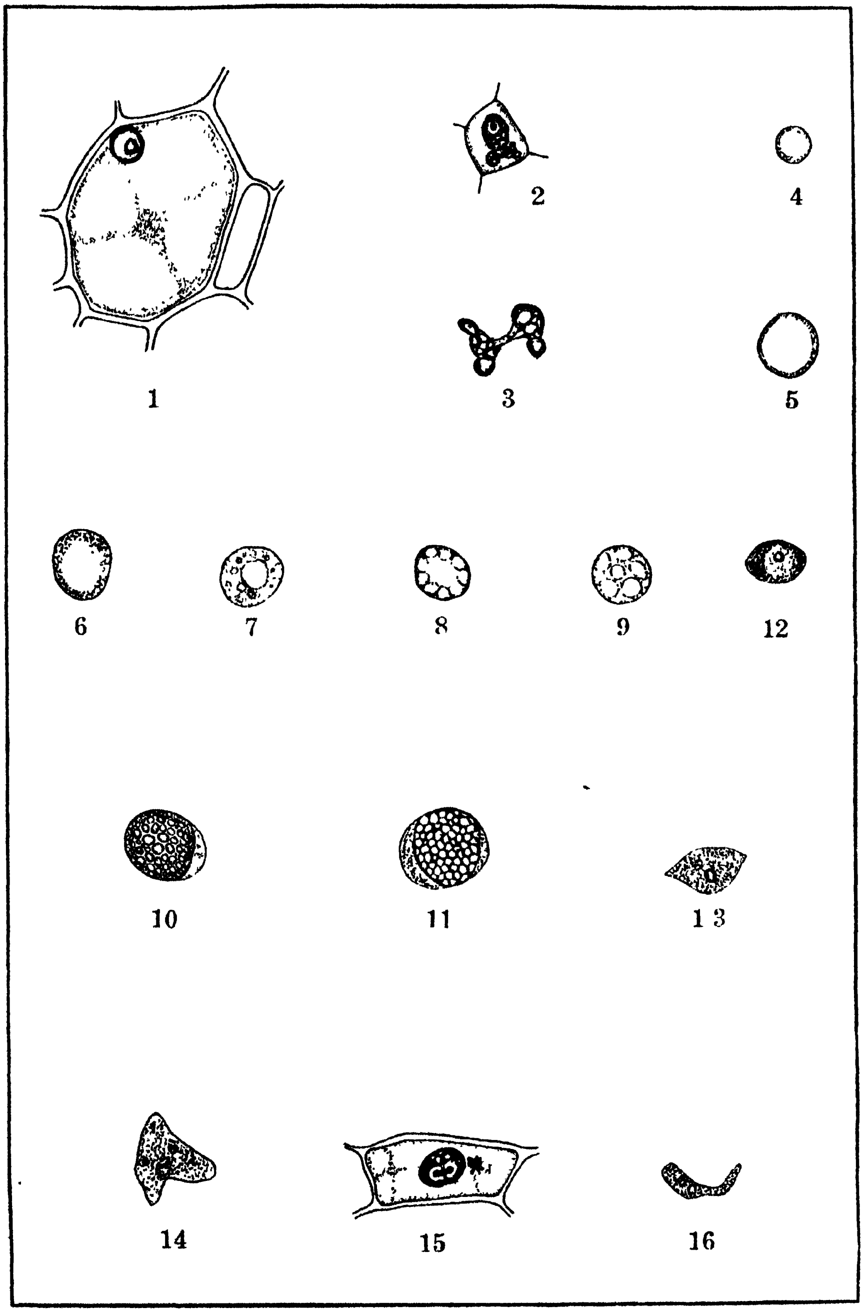

PLATE II.

SOME CESTODES FROM DOMESTIC ANIMALS IN THE PHILIPPINE ISLANDS THAT ARE OF ECONOMIC AND HYGIENIC IMPORTANCE

By BENJAMIN SCHWARTZ[1]

Of the College of Veterinary Science

The object of this paper is to record the presence of cestodes and cestode diseases that I have thus far encountered in domestic animals in the Philippine Islands. The records are based on post-mortem findings in the clinic of the College of Veterinary Science, in the Azcarraga abattoir in Manila, and, as noted elsewhere in this paper, on specimens received from some of my associates in the University of the Philippines.

Many more species than those recorded in this paper doubtlessly occur in the Philippines. Systematic autopsies will probably reveal many additional forms, at least the more common species of cestodes that are known to occur in domestic animals in other parts of the world, and that are not included in the following pages.

MEASLES IN CATTLE AND SWINE

As used in veterinary medicine, the term "measles" refers to pathological conditions primarily in cattle and swine, due to the presence in the musculature of these animals of bladderworms or tapeworm cysts, the adult forms of which are strobilate tapeworms that occur in the small intestine of man. Two species of Taenia from man, namely *Taenia solium* and *Taenia saginata,* have been recorded from the native population in the course of various helminthological surveys, the source of infection with these parasites being "measly" pork and "measly" beef, respectively.

BEEF MEASLES (CYSTICERCUS BOVIS)

Beef measles is a pathological condition in cattle due to the presence of *Cysticercus bovis*, the larval stage of *Taenia saginata*, in the musculature of these animals. So far as I know, this parasite has not been reported from native cattle. In a former paper (1) I called attention to the fact that the records of the Bureau of Agriculture show that imported cattle from French Indo-China that are slaughtered in Manila are remarkably free from *Cysticercus bovis* infection because only two cases of infestation with this parasite have been found in about thirty thousand animals that were examined during a period of six years. The occurrence of *Cysticercus bovis* in native cattle, though not definitely recorded, may be taken for granted, however, in view of the fact that the adult form, *Taenia saginata*, has been recorded from time to time in inhabitants of the provinces, many of whom must have acquired the infection from native beef.

Cysticercus bovis occurs in various muscles, notably the heart, the muscles of mastication, the diaphragm and the tongue. The presence of these parasites may be discovered by thoroughly inspecting cattle carcasses that are intended for human consumption.

[1] Experiment Station Contribution No. 98.

Man becomes infested with the adult tapeworm as a result of swallowing raw or insufficiently cooked measly beef. From the viewpoint of meat inspection, carcasses that are heavily infested with *Cysticercus bovis* and carcasses that show a moderate or even light but generalized infestation with this parasite are unfit for human consumption and should be condemned. Slightly infested carcasses may be passed for food after all the visible cysts have been removed, but the meat from such carcasses must be thoroughly cooked, as many cysticerci may escape detection. According to Ransom (2) infested carcasses may also be rendered innocuous by refrigeration or pickling for a period of three weeks.

Since cattle become infested with *Cysticercus bovis* as a result of swallowing the shelled embryos of *Taenia saginata* that are expelled from the human host with the feces, the prevention of measles in bovines is dependent upon the proper disposal of human feces. The placing of human feces where live stock may have access to it, or where it may contaminate feed or water of live stock, favors the perpetuation of measles in cattle and thus renders man liable to infection with the adult tapeworm.

An efficient system of meat inspection will, of course, do much to eradicate this parasite. In the Philippines, however, meat inspection is practically nonexistent outside of Manila and the chief emphasis must be placed therefore on thorough cooking of meat and on the proper disposal of human feces. The latter precaution will also aid in eradicating other intestinal borne diseases, such as typhoid, dysentery, cholera, etc.

PORK MEASLES (CYSTICERCUS CELLULOSAE)

Pork measles is a pathological condition in hogs due to the presence of *Cysticercus cellulosae*, the larval stage of *Taenia solium*, in the musculature of these animals. These parasites are of rather common occurrence in native swine. The records for Manila for a period of six years during which period nearly six hundred thousand hogs were slaughtered, show that from one to one and a half per cent of these animals are infested with *Cysticercus cellulosae*. The detailed records have been published elsewhere (1).

Cysticercus cellulosae occurs principally in the tongue, the muscles of mastication, and the muscles of the shoulder and of the neck and in the diaphragm. The parasites may be detected by meat inspectors in the course of routine examination of hog carcasses.

Man becomes infested with *Taenia solium* as a result of swallowing insufficiently cooked measly pork. Swine acquire the infection with cysticerci as a result of swallowing the shelled embryos that are eliminated with the feces of human beings harboring *Taenia solium*.

Heavily infested hog carcasses should be excluded from human consumption altogether and lightly infested pork should be thoroughly cooked before being eaten. In this connection it should be remembered that a person that harbors *Taenia solium* may also become infected with the larval stage of the parasite as a result of contaminating his hands with his own feces, and thereby contaminating his food, or he may become infected in some other way. In man the cysticerci may lodge in the muscles, in the eye, in the brain and in other organs.

In view of the avidity with which hogs devour human feces, heavy infections of measles is much more common in hogs than in cattle. The recommendations concerning the proper disposal of human feces in order to prevent measles in cattle apply with even greater force to the eradication of measles in hogs.

From economic and hygienic viewpoints *Cysticercus bovis* and *Cysticercus cellulosae* are the most important cestodes in domestic animals, because carcasses that are heavily infested with these bladderworms are generally unfit for human consumption, thus causing a distinct economic loss, and because these cysticerci are the intermediate stages of tapeworms that commonly occur in man.

HYDATID DISEASE (ECHINOCOCCUS)

The term hydatid disease is applied to pathological conditions in cattle, sheep and swine due to infestation with the larval stage of a tapeworm, the adult form of which occurs in the intestine of dogs, and is known as *Echinococcus granulosus*. The cysts, which may attain considerable size usually occur in the liver and lungs, but may occur in any organ. The larval stage also occurs in man, causing a serious, and often fatal disease, but infestation with this parasite is comparatively rare in human beings.

Wharton (3) states that several cases of infection of man with the larvae of Echinococcus have been recorded in the Philippines and he also states that he has been unable to find any authentic records of the occurrence of the adult tapeworm in native dogs. I have examined over fifty native dogs and I have not found *Echinococcus* in these animals.

So far as concerns the occurrence of the larval stage of *Echinococcus* in domestic animals in the Philippine Islands, I am able to report two cases from cattle through the courtesy of Dr. A. K. Gomez, who placed the material at my disposal. In one case a cyst was found in the heart of a cow that was autopsied in the College of Agriculture at Los Baños, and in the second case cysts were found in the lungs of an Indian buffalo autopsied in Manila.

CYSTICERCUS TENUICOLLIS

Cysticercus tenuicollis is a larval tapeworm that occurs in the abdominal cavity of cattle, sheep and hogs. The bladderworms are usually attached to the mesenteries and to the omentum. The adult stage of this cestode occurs in the intestine of dogs and related carnivores.

I have been able to examine several specimens of *Cysticercus tenuicollis* from hogs from the province of Pampanga, through the courtesy of Dr. M. A. Tubangui.

Thus far, the adult tapeworm (*Taenia hydatigena*) has not been recorded from native dogs, but the occurrence of this parasite in these animals may be inferred from the occurrence of the larval forms in hogs.

TAENIA TAENIAEFORMIS

In view of the fact that no tapeworms belonging to the genus *Taenia* have been recorded heretofore from carnivores, namely dogs and cats, in the Philippines, it may be of interest in this connection to note the occurrence of *Taenia taeniaeformis* in native cats. These parasites, though by no means very common, have been found in the intestine of cats by the writer and his students. The larval stage of this parasite, *Cysticercus fasciolaris*, is of common occurrence in house rats and in field rats, as well as in mice in the vicinity of Los Baños.

MONIEZIA EXPANSA

Through the courtesy of Dean C. F. Baker I secured a single specimen of *Moniezia expansa* from cattle in Mindanao.

MONIEZIA TRIGNOPHORA

Several specimens of *Moniezia trignophora* were collected from the intestines of native sheep at the Azcarraga abattoir, Manila. This parasite is not of very common occurrence in sheep that are slaughtered in Manila.

ANAPLOCEPHALA

Two species of Anaplocephala, namely *Anaplocephala perfoliata* and *Anaplocephala mamillana* occur in native horses, the former species being very common. I have collected these parasites from the intestine, colon and caecum of horses killed in the clinic of the College of Veterinary Science.

HYMENOLEPIS

In view of the fact that two species of Hymenolepis of common occurrence in rats also occur in human beings, it is of interest to note that rats trapped on the college grounds at Los Baños are nearly always parasitized with *Hymenolepis diminuta* and *Hymenolepis nana*, species that have been recorded from the native population.

DIPYLIDIUM

Dipylidium caninum is of common occurrence in native dogs. Species of Dipylidium are also very common in native cats.

Dipylidium caninum has also been recorded from human beings, and a note on its occurrence in a Filipino child was published by Mendoza-Guazon (4).

DIPHYLLOBOTHRIUM

I have received specimens of cestodes from dogs belonging to the genus of *Diphyllobothrium* from a veterinary hospital in Manila. These parasites are not very common, but they are by no means rare in native dogs. I have not found any cases of infestation with these parasites in dogs or cats in the course of my autopsy work on these animals. Wharton (3) reports, however, the occurrence of Diphyllobothrium in native dogs and cats and states that these parasites are very common in the latter host.

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IMPROVEMENT OF THE LANZON (*Lansium domesticum* Jack)

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ONE PLATE

In the order of importance, the problems in lanzon breeding are: (a) Multiplication of the sweetest varieties, (b) multiplication of the varieties producing a small percentage of seeded fruits and the search and propagation of seedless varieties or bud mutations, (c) the elimination of the milky juice of the rind and the bitter taste of the covering of the seed, (d) elimination of the "rags", or the loose tissues lying at the center of the fruit and between the fruit segments, and (e) the production of better yielding strains. The first four concern the consumer more than they do the grower. The lanzon is on the market for a brief season and there has never been a serious oversupply so that the consumer buys whatever is offered him. He may discriminate against small size or sour fruits, when larger and sweeter kinds may be had, if not, he buys anyway what is sold. If the grower could offer him improved fruits, he may be sure to get a better price. From the grower's standpoint, the last problem, that of yield, is probably the most important. If he could increase his output of fruits even without improvement in quality, he is bound to get more profit as there is always a demand for the fruits. At times the lanzon sells cheap in Manila and in its immediate vicinities and it would seem then that the market is glutted. This seems to be the case during the height of the lanzon season. Undoubtedly, a wider sale of the fruit in the Philippines, which is bound to increase as transportation facilities are increased, will for a long time to come take care of any increase in production which the growers may be able to make.

METHODS OF IMPROVEMENT

Each owner of lanzon plantations is probably more or less familiar with his trees. If a close friend approaches him for an order of special fruits for purposes of a present, "regalo", to a third party, the owner tells immediately from what tree the fruits should be gathered. If the tree indicated is without ripe fruits then or has an insufficient number of ripe fruits, he points to a second or a third tree. The question of variability and location of desirable trees is then more or less settled as far as each owner and his own trees are concerned. The problem is to propagate the desirable trees. Probably the grower gets his seeds for his own use from the trees which he considers most desirable. Whether or not the plants which he gets from these seeds come true to type is not known and it seems that this is an essential question for the lanzon breeder to study. Meanwhile it may be assumed that lanzon seedlings are more or less variable in regard to many of their important characters. If the lanzon could be propagated in a large scale by vegetative means, the question will dwindle in importance for by such method of propagation, seminal variability is practically avoided. At present, however, the lanzon is propagated by native growers practically by seed only. Since the

[1] Experiment Station contribution No 99.

lanzon may be marcottaged, a method already practiced successfully by the growers of the chico, or the sapodilla, and one that is simple, efforts should be made by the extension elements of the Government to encourage growers to propagate their best and most productive trees by marcottaging while at the same time they are distributing grafted plants.

The College of Agriculture and specially the Bureau of Agriculture distribute lanzon seedlings. There is here a chance to introduce gradual improvement. Instead of distributing seedlings without regard to parentage, only seedlings from known desirable parent trees, selected on the basis of the problems of improvement already mentioned, should be distributed to prospective planters. What is better, scions from selected trees and grafted on seedlings, may be distributed in a larger scale than it is done at present.

The lanzon plantations in the Philippines should be surveyed, as fast as facilities will allow, for their plant breeding possibilities. The survey should include not only a comparative study of individual trees but also a study of bud variations within the tree. It is known for example that certain trees bear mostly seedless fruits. It is not impossible that some parts of these trees are bud sports as to seedlessness.

The survey could be done without much expense. During the season, tree owners "let" their plantations to what may be termed middlemen who pay a certain sum to the owner as payment of the fruits. The middleman then takes care of the harvesting and the sale of the harvest. In this way he often gets a fair profit. Should the Government undertake a thorough survey for desirable trees it can do the same as the middleman,—rent the trees and study them also, except that it has to open some fruits in the study. The rest of the fruits may be sold.

VARIABILITY

Fruit.—It is commonly known that as to sweetness there are at least two varieties of fruits,—the sweet and the sour. A middle class is also found, one which is neither sweet nor sour. The lanzon from Paete, Laguna, is reported to be generally of the sweetest variety. Growers of San Pablo, Laguna, however, make strong claims that the San Pablo lanzon is no less sweet, and that if it is sour, it is merely due to the fact that it is not allowed to ripen fully before it is picked. As to shape of fruit, two varieties are recognized. These are the round and the elongated. The elongated is generally, if not always, a sweet variety also. Sweetness is usually indicated by a blackish area at the end of the fruit around the stem, due to infection by mildew. The correlation is so well established that even little children can pick the sweet fruits in a mixture on the basis of this association of characters. Aside from these types, there are also the fully seeded fruits, those with only one segment bearing seed and those practically seedless. Dean Baker says he was told by Mr. Wester, of the Bureau of Agriculture, that there are trees known which are producing all seedless fruits from year to year.

Types of trees.—The question which immediately arises is whether the trees may be classified on the basis of the variability found in the fruit. Are round and elongated or sweet and sour fruits borne in the same tree?

In an attempt to find an answer to these and related questions, a study was made of the variability in a number of characters including those which decide

the commercial value of the lanzon fruit. This study was made by the Division of Genetics, in 1919, and previously in 1915, under Professor Baker. The 1919 study performed by Mr. Simeon Panganiban under the immediate direction and supervision of the author covered the towns of Nagcarlang, Paete, Alaminos, San Pablo, and Lilio, Laguna Province. It must be remarked, however, that the lanzon is also grown in other provinces specially in those belonging to the Visayan and Moro regions.

As a result of the 1919 study, six distinct types of trees, distinguished according to fruit characteristics specially, were discovered. These types may be described briefly:

Type 1.—Fruits are irregularly ellipsoid, generally large, seedy, and of poor flavor and quality. The branches of the tree are spreading, a characteristic which is not common.

Type 2.—Fruits are roundish to ellipsoid, very small to medium in size, seedy, of poor flavor and quality, and fruits in bunch do not mature uniformly.

Type 3.—Fruits are obovate or obconical borne very crowded in the bunch, medium in size and of good flavor.

Type 4.—Fruits regularly obovoid, small to medium in size, characterized by a high degree of seedlessness (77 per cent of fruits may be seedless), of excellent quality, a heavy yielder, sometimes fruiting two times a year.

Type 5.—This is the most common type. Fruits ellipsoid, variable in size, medium size predominating, seedy and fair in flavor.

Type 6.—Fruits ellipsoid to ovoid, medium to large in size, fair in quality, ripens uniformly in the bunch and trees may bear twice a year.

Some of the more important and detailed characteristics of the different types are shown in Table I.

TABLE I.—*Fruit and seed characters of different types of lanzon*

Type number.	Fruit dimensions.	Av. wt. of fruit.	Seed dimensions.
	cm.	*gm.*	*cm.*
1	4.4×3.5	28.5	1.6×1.1
2	3.6×3.0	17.6	1.5×1.0
3	4.0×3.2	24.6	1.4×0.9
4	3.4×2.7	18.3	1.4×1.0
5	3.9×3.1	22.0	1.4×1.0
6	4.3×3.3	24.2	1.4×1.0

The characteristics of the different types regarding yield; flowering, fruiting and ripening; and eating qualities are given in Tables II, III and IV respectively.

TABLE II.—*Yield and age of each of six trees of each type in "kaing," or crate.*

Type.		Trees.						Average.
		1	*2*	*3*	*4*	*5*	*6*	
1	Yield in crates.	1 1	1 5	1 9	1 4	2 6	1 5	1.7
	Age in years	45	45	35	40	35	30	
2	Yield in crates	1 7	2 0	2 5	1 6	1 7	2 5	2 0
	Age in years .	50	45	55	45	37	50	
3	Yield in crates	2 3	2 7	1 9	2 5	3 0	2 7	2 5
	Age in year . .	35	45	50	55	45	55	
4	Yield in crates	2 8	3 0	3 5	2 5	2 2	3 7	2 9
	Age in year .	50	55	45	40	35	55	
5	Yield in crates	1 2	2 0	1 8	1 5	2 3	1.0	1 6
	Age in years .	35	45	40	50	55	27	
6	Yield in crates .	2 5	2 0	2 5	2 7	1 8	3 0	2 4
	Age in years . .	45	50	55	40	35	45	

TABLE III.—*Flowering, fruiting and ripening in 1919*

Type.	Date flowered.	Date fruited.	Date ripened.
1	June 20	August 3	October 30
2	June 20	August 3	November 9
3	June 20	August 3	October 30
4	June 30	August 3	November 9
5	June 20	August 3	October 30
6	June 20	August 3	October 30

TABLE IV.—*Flavor, quality and seed characteristic.*

Type.	Flavor.	Quality.	Seed.
1	faintly acid	poor	large seeded
2	very poor	very poor	seedy
3	good	good	less seedy than type 2
4	excellent	excellent	77 per cent seedless
5	sweet	good	
6	sweet	fair	

Previously, De Leon (1) reported practically the same six types.

Of the above types, No. 3 and No. 4 are very desirable for multiplication, and those interested should follow this work up and try to obtain seeds or vegetative parts of these trees for propagation. Types Nos. 1, 2, 3 and 4 were found in the plantation of Mr. Mariano Noble in barrio Ibabang Sungi, Lilio, Laguna. Type No. 4 was also represented by trees owned by Mrs. Luisa of Sta. Cruz, Laguna, and in 1919 in charge of Mr. Pedro Pondiga, barrio Calumpang, Nagcarlang, Laguna. Trees of Type No. 5 were found in the plantation of Mr. Esteban Villarin, Paete, Laguna, and of Mr. Vicente Buenaseda, Ibabang Sungi, Lilio, Laguna. Trees of No. 6 were found in the lot of Mr. Santiago de la Peña, Ibabang Sungi, Lilio, Laguna.

It is not known at present if those types are able to reproduce their forms by seeds.

Factors which may cloud hereditary variability.—In plantations, like those in the Philippines, in which the trees are not placed at regular distances, it may be necessary in a comparative study of trees to omit those which are conspicuously at an advantage as to space. Other factors in a plantation which may cause some trees to be apparently, even if not truly, better than other trees, are slight shade, and better soil, which is believed to be clay loam with fair drainage.

SOME IMPORTANT ENEMIES

It is to be regretted that a number of known desirable trees have died or are soon to die due to the effect of parasitism of the Loranthus. It is to be wondered why the owners of the lanzon trees do not take early steps to kill this parasite to save their trees. Another serious cause of the death of lanzon trees is apparently an attack by some weevil on the bark, causing gradual death of the branches and ultimately of the whole tree. An example of a tree thus affected is found near the residence of the manager of the Hacienda Calauang. The writer accompanied Dr. Uichanco, of the Entomology Department of this College, to the place for the purpose of studying the pest. Insects living in or below the bark were collected and undoubtedly a study of these specimens is underway. Professor Raymundo, of the Agronomy Department, claims that in Pila his lanzon trees once suffered from a similar if not identical trouble and that an effective control which he discovered, and possibly practiced by other lanzon owners, is to merely clean the trunk and branches using the ordinary native broom. The Departments of Botany and Entomology should find in these two serious enemies of the lanzon an inviting field of investigations along very practical and immediate lines.

ASEXUAL PROPAGATION OF THE LANZON

For those who may want to hybridize lanzon or propagate it asexually, it is necessary to remark that fifteen trials to root cuttings made in this College failed. Several hard wood cuttings calloused but none made roots. Marcottaging, however, was successful, the rooting in this case requiring about 134 days from the time of setting. It is said that plants produced by Chinese layering, or air layering, come to bearing earlier than those propagated by seeds, the plants grown from the latter producing fruits not earlier than 12 to 15 years of age. A distinct advance in the vegetative propagation of lanzon has been made by the Bureau of Agriculture. Wester (2) recommends cleft or side grafting, and the use of well matured, but not of old growth, scion which is preferably

6-8 centimeters long, about a centimeter in diameter and inserting it in a stock 6-10 centimeters above ground. Mr. S. Capistrano, in charge of the Singalong Experiment Station, and his assistant, Mr. I. Victorio, have also demonstrated that grafting may be done easily with lanzon. The trunk of the stock used has a diameter of about one centimeter or more and it is said that about 70 per cent success is obtained. Trials of budding have been practical failures. Because seedlings of santol, *Sandoricum koetjape* (Burm. f.) Merr., which belongs to the same family as the lanzon, may be grown very easily in abundance, attempts were made to graft lanzon on seedlings of this species. No success, however, has yet been obtained, but the thing is not considered at present as impossible. The trials were made during the hot season and it is suspected that too much heat was one of the factors which contributed to the failure of the scion to set. This work is wrapped up with great possibilities as santol seedlings are produced even naturally in great numbers, while lanzon seedlings are very slow growing and very difficult to grow.

SEARCHING FOR SEEDLESS BUD MUTATIONS

Correlation between degree of seediness and shape of fruit.—This lanzon season, the Division of Genetics has made the beginning of a direct attempt to discover seedless bud mutations. This work is partly being carried out by Mr. J. Pagsolingan, a senior student, and consists in going to those plantations in which highly seedless forms are known to exist, and sampling the branches of individual trees. Trees in other, previously unexamined plantations are also studied. As soon as a fruit in a given bunch of a branch is found with even a single seed, the test is considered sufficient to demonstrate that the branch in question was not a seedless bud mutation.

In this method of sampling, the sample fruit is opened. For this reason, the method is more or less expensive and it becomes necessary to have a less expensive one.

It is believed one such method has been discovered which consists in using a particular shape of the fruit as an index of entire seedlessness. It has been found that any asymmetry is a good indication of the presence of one or more seeded sections in the fruit, the larger side being the seedy portion. Symmetry may indicate complete seediness or complete seedlessness. If the fruit is symmetrical from all angles and at the same time the stem half is distinctly elevated in one or several parts which correspond to the sections inside, the fruit is more or less completely seedy. The elevation is due to the presence of the seed which is always found occupying the stem half more than it does the basal half of the seedy section. On the other hand, if the symmetry is accompanied by a certain pointedness or a tapering appearance or the complete absence of the distinct elevation on the stem half, the fruit may safely be considered as entirely seedless. By seedless in this case is meant the absence of the hard kernel mainly constituting the seed. Seedless segments possess merely a trace of the seed coat which in this case looks more like the "rags" found in the center of the fruit, and is brownish, standing in clear contrast with the transparent edible portion of the fruit. The question has been raised whether absence of elevations may not result also from overcrowding of the fruits in a bunch. It is considered at present that crowding does not exist to such an extent as to prevent the production of elevations due to seediness.

Entire absence of seed is also generally correlated with small size. However, whether the fruits are small or larger, if they are entirely seedless, the correlation between shape and seedlessness still holds. It would be enlightening to report here that the correlation between seedlessness and symmetry of fruit was determined mathematically for 478 fruits, using Yule's formula, $(C = \frac{ad - bc}{ad + bc})$, and this correlation was found to be + 0.741, a very significant index, with a probable error of $\pm$ 0.014. The 478 fruits were first grouped into non-symmetrical and symmetrical classes. Each group was then examined for seedlessness and there were found (a) 208 non-symmetrical, seeded, (b) 102 non-symmetrical, seedless, (c) 39 symmetrical, seeded, and (d) 129 symmetrical, seedless. It will be seen that the correlation is not perfect, but it is very significant, there being a greater error in the correlation between non-symmetry and seededness than in between symmetry and seedlessness. With the above correlation known it should be possible for a retail buyer to select seedless fruits. The habit of selecting seedless fruits in buying should be taught to the people, for once adopted, it may create a big demand for seedless fruits only, and this condition will help in improvement of the lanzon fruit.

Parthenocarpy and seedlessness.—There is a problem which is to be faced in the search for seedless bud mutations. This problem is the presence or absence of parthenocarpy in lanzon. Obviously, if the lanzon is parthenocarpic, that is, if it is capable of producing the fruit without pollination, thereby producing seedless fruits, then, even if a seedless branch is found, there is still the question of whether this seedlessness is a case of bud mutation or one merely of parthenocarpy. If the latter, then the branch or the new plant that may be grown from this may be expected to be seeded the moment pollination takes part during blooming.

It is therefore necessary to study parthenocarpy in the lanzon. The fact that in a given fruit several sections are found seedless while the remaining ones are seedy may be a good indication that the lanzon is parthenocarpic. Moreover, it is known that when fruiting suffers from the effect of bad weather or typhoons, the fruits produced under this condition are invariably seedless, whereas the same tree under normal conditions produces both seeded and seedless fruits in a bunch.

ACKNOWLEDGEMENT

The illustrations accompanying this article were drawn by Mr. Moises Villaluz, the College painter.

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ILLUSTRATIONS

PLATE 1

Fig. 1.—Lanzon fruits showing their relative position in the bunch

Fig. 2.—(*a*) A cluster of flower buds. (*b*) A cluster of undersized fruits resulting from the effect of typhoon. These fruits were seedless.

Fig. 3.—(*a*) A group of asymmetrical fruits showing elevated, seedy sections (*b*) A group of symmetrical fruits, symmetry being indicative of entire seedlessness. (*c*) Segments of fruits showing seed. (*d*) Segments which are seedless and showing traces of seedcoat inside, but none of the hard kernel of the seed. The seeds removed from the sections and the rags or traces of the seed coat are shown in (*e*) and (*f*) respectively.

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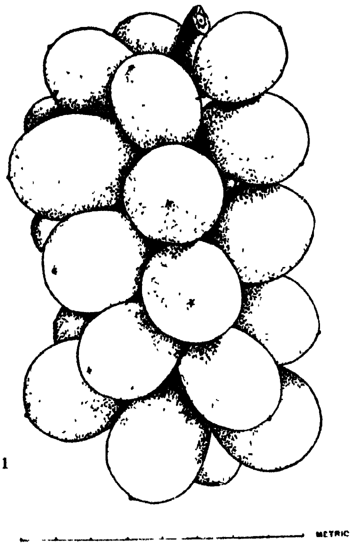

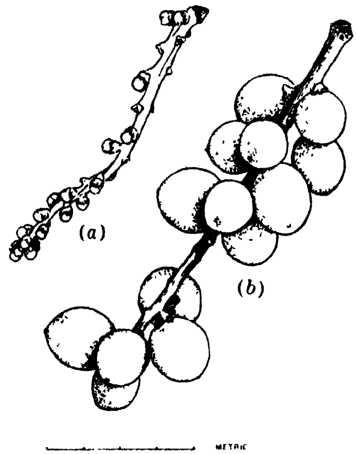

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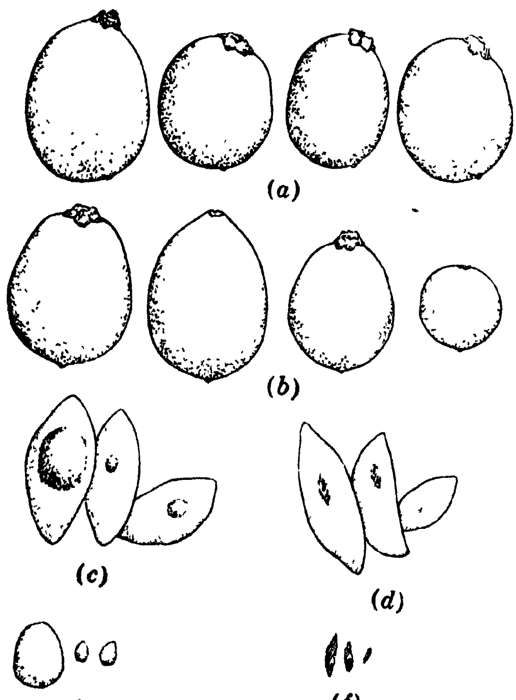

PLATE I.

COLLEGE AND ALUMNI NOTES

Pedro L. Montellano, '15, who was once a member of the staff in the Chemistry Department of this College is now in charge of Animal Husbandry in the Central Luzon Agricultural School at Muñoz, Nueva Ecija. Mr. Montellano, as may be recalled, resigned from his position in the College to accept a post in the Bureau of Education. He was sent as a government pensionado from the Bureau of Education to specialize in Animal Husbandry at the University of Wisconsin where he was conferred the degree of Master of Science in 1921. From there he went to Cornell University where he stayed another year, specializing in Rural Education. He arrived in Manila on June 7, 1922.

Joaquin J. Gonzalez, '19, writes that he is now the proud father of a baby boy born on September 13, 1922. Mr. Gonzalez after his graduation went to farming. He is now in charge of a farm of over one thousand hectares.

Severo G. Yap, '21, was married to Miss Asunción Montesclaros of Cabalian, Leyte, in August 12, 1922. Mr. Yap is now the technical agricultural assistant to the Provincial Governor of Lanao.

Basilio F. Ponce, '22, is the head landscape gardener of the City of Manila. His present address is No. 6, Interior, Cabral St.. Ermita, Manila.

Pedro R. Hernais, '22, recently left for Baguio to accept a position in the Bureau of Education. He expects to teach Biology and Geometry in the Baguio High School. Mr. Hernais was a graduate student in this College before he left.

Gaspar Lindayag, '19, passed away, on September 27, at the Philippine General Hospital. He had contracted a fever while taking part in the locust campaign at Nueva Ecija.

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HERPETOLOGICAL FAUNA OF MOUNT MAKILING[1]

By EDWARD H. TAYLOR

The faunal survey which has been proposed for the Mount Makiling Forest Reserve is a noteworthy plan. In view of this proposed survey it seems worth while to record a list of species of the amphibia, turtles, lizards, and snakes now known to occur on Mount Makiling and about its base.

The following records are based on collections of the College of Agriculture and the Forest School, made by the faculties and students of the two institutions; and on various collections made by me at intervals between 1914 and 1922.

The list of species represents the characteristic reptilian and amphibian fauna but it should not be regarded as complete. It is quite probable that other known species as well as new species will be found to occur on the mountain. Few collections have been made at high elevations, and it is there that the collector will probably find most species as are included in the Makiling fauna and not recorded in this list.

TURTLES

Cyclemys amboinensis (Daudin).

This turtle is not uncommon along the Molawin, a small creek which flows through the campus of the College of Agriculture. Specimens are occasionally found away from water in the forest. Males and females show much variation in the shape of the carapace but they are uniform in head markings. Many specimens collected.

AMPHIBIANS

Key to species of amphibians found on Mount Makiling.

a^1 Upper jaws with teeth (Family RANIDÆ).

b^1 Tongue oval, entire, without a notch in posterior part—OXYGLOSSIS LÆVIS Günther.

b^2 Tongue deeply notched behind.

c^1 Toes more or less webbed, with or without pads on toes and fingers; no web between fingers.

d^1 No pads on toes or fingers.

e^1 No free skin flap on outer side of fifth toe and metatarsus —RANA MOODIEI Taylor.

d^2 Small rounded pads on tips of toes and fingers.

[1] Experiment Station Contribution No. 103.

e[1] Toes almost fully webbed; no dorsolateral dermal folds; no distinctive spot on tympanum; very large frogs—RANA MAGNA Stejneger.

e[2] Toes about three-fourth webbed; narrow dorso-lateral folds present in both young and adults; a distinctive spot on tympanum; medium size—RANA WOODWORTHI[1] Taylor.

e[3] Toes about two-thirds webbed, no dorsolateral folds; two bronze or cream colored dorso-lateral stripes, usually meeting on tip of snout—RANA SIMILIS (Günther).

c[2] Toes strongly webbed; fingers with or without webs; tips of digits of hands and feet with very broad adhesive disks; arboreal frogs.

d[1] Fingers with well developed web; body mottled gray or reddish brown—POLYPEDATES PARDALIS (Günther).

d[2] Fingers almost entirely without web; body marked with six longitudinal dark stripes or with a few scattered spots—POLYPEDATES LEUCOMYSTAX (Gravenhorst).

c[3] Fingers and toes with rounding tips and without webs.

d[1] Elongate, narrow, curved, folds on shoulders beginning behind eye; gray to reddish above, dark on sides of head and body—CORNUFER CORRUGATUS (Duméril).

d[2] Numerous rounded or elongate tubercles on back; extremely variable in color and markings—CORNUFER MEYERI (Günther).

a[2] No teeth in upper jaw (Family BREVICIPITIDÆ).

b[1] Fingers and toes with small rounded tips—KALOULA PICTA (Bibron).

b[2] Fingers dilated at tips into broad truncate disks—KALOULA BALEATA (Müller).

Family RANIDÆ

Oxyglossus lævis Günther.

This species is found in the mountain streams and in rain pools scattered through the forest. The frogs are almost invariably found in water or among rotting leaves about the forest. I have collected numerous specimens up to nearly 500 meters elevation. They probably occur at higher elevations.

Rana moodiei Taylor.

This species is confined to the lowlands. It is not rare along Molawin creek. I have never found it at an elevation higher than the Forest School. Many specimens collected.

Rana vittigera Wiegmann.

This species, like the preceding, is a lowland form, usually found in moist situations. I have never taken it at an elevation higher than the Forest School.

Rana magna Stejneger.

This large species is found along the mountain brooks and streams. The adults reach a large size. They are usually seen perched along the banks of the streams. They take to the water at the least disturbance, and remain under water several minutes. Several specimens collected.

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[1] The description of this species is in press in *Philippine Journal of Science*.

Rana woodworthi Taylor.

This species is common along the mountain streams at low elevation. I collected an excellent series in one of the streams running about midway between Camp Eldridge and the College of Agriculture. The stream was nearly dry and the frogs had congregated in the small stagnant pools. Many specimens taken.

Rana similis (Günther).

Los Baños is the type locality of this species.

I have collected a number of specimens in the small stream which empties into Laguna de Bay near Los Baños. They are usually found near water, concealed under logs, rocks or heavy undergrowth. They rarely take to water to escape capture, and if they do enter the water, they do not remain below the surface any considerable length of time. In color they are bronze to blackish above, with two cream or yellow lines along each side of the body. Many specimens taken.

Polypedates pardalis (Gunther).

I have examined only a single specimen of this rare frog from Mount Makiling. It is in the collection of the Forest School. It is a shy form, usually found in trees or in the axils of banana and abaca leaves. It may be identified easily by the webbed hand. It is a rather large form. The eggs are laid in balls of yellow foam about rain pools or small brooks.

Polypedates leucomystax (Gravenhorst).

This is the common tree frog and occurs chiefly at low elevation. I have not taken it above 500 meters. The large pads on the tips of the fingers and toes make this and the preceding species easily recognized. This species, however, has no conspicuous web between the fingers. Specimens vary in markings. Many specimens have six, broad, dark lines on the back; others have only a few irregular spots. The eggs are laid in masses of creamy white foam in the edge of water or on branches of trees and shrubs extending over the water. Many specimens taken.

Cornufer corrugatus (Duméril).

This species probably occurs to the top of the mountain since I have taken it at a point within 200 meters of the summit. It is a woodland form and is rarely found in the vicinity of water. Specimens vary greatly in color. Individuals may be either red, white, gray, orange, flesh, or brown. The regular, elongate folds on the anterior part of back are usually evident. Many specimens collected.

Cornufer meyeri (Günther).

"Los Baños" is given as the type locality for this species. It is very common. The young are usually found along the streams; the adults are found moving about in the forest. The individuals vary greatly in color and markings and rarely can two specimens be found that are alike. This and the preceding form may be distinguished from other Makiling frogs by the slender fingers and toes without widened pads or webs. They probably occur to the summit of the mountain. It is not improbable that more than one closely re-

lated species is represented in the large series of specimens taken, all of which I have designated *Cornufer meyeri* for want of stable characters to differentiate the color forms.

Family BREVICIPITIDÆ

Kaloula picta (Bibron).

This narrow-mouthed toad is not uncommon at low elevations. It is nocturnal in habit, usually burrowing under loose earth in the day time. It apparently does not approach water, save during the breeding season when many individuals congregate about rain pools to lay their eggs. Many specimens collected.

Kaloula baleata (Müller).

This species has been reported from Los Baños. A specimen collected by Dr. Meyer is in the British Museum. I collected a single very young specimen, which I have identified as this species, in the small stream which empties into Laguna de Bay near Pansol. The species differs from the preceding one in having broadened pads on the fingers and toes. Only these two specimens have been taken.

LIZARDS

Key to lizards known from Mount Makiling.

a^1 Body without scales except on belly (Family GEKKONIDÆ).

- b^1 Tips of digits not dilated; adhesive pads absent—GYMNODACTYLUS PHILIPPINICUS Steindachner.
- b^2 Tips of digits dilated; adhesive pads present.
  - c^1 Body and tail with numerous low spiny tubercles, (Small house geckoes)—HEMIDACTYLUS FRENATUS Duméril and Bibron.
  - c^2 Body without tubercles;
    - d^1 A flap of skin along the sides of belly—COSYMBOTUS PLATYURUS (Schneider).
    - d^2 No skin flap on sides of body.
      - e^1 Tail semi-cylindrical without serrate edge—PEROPUS MUTILATUS (Wiegmann).
      - e^2 Tail flattened with serrate edge—HEMIDACTYLUS GARNOTII (Duméril and Bibron).
  - c^3 Body without rounded tubercles; latter becoming trihedral on tail; large geckoes (*tukko*)—GEKKO GECKO (Linnæus).

a^2 Body covered with scales.

- b^1 Tongue not forked. Head short.(Family AGAMIDÆ).
  - c^1 Broad lateral expansion of skin supported by ribs, used as wings —DRACO SPILOPTERUS (Wiegmann).
  - c^2 No dermal expansion.
    - d^1 Body somewhat compressed, with tail extremely long, slender; usually green in color; a spiny nuchal crest present in adults —CALOTES MARMORATUS (Gray).
    - d^2 Large lizards with a slight nasal crest; a serrate nuchal crest, and a fan shaped crest on tail; crest very large in adult males (*Iguana, balubid*)—HYDROSAURUS PUSTULOSUS (Eschscholtz).

b² Tongue forked; body covered with juxtaposed scales; large black and yellow lizards (*bayawak*) (Family VARANIDÆ)—VARANUS SALVATOR (Laurenti).

b³ Tongue not forked; body covered with shiny imbricating scales (Family SCINCIDÆ).

- c¹ Scales with numerous low keels.
  - d¹ No postnasal scale; body scales iridescent, with 5 or 7 keels—MABUYA MULTICARINATA (Gray)
  - d² A postnasal scale; body scales olive to olive brown, with 3 or 5 keels. Females sometimes with small light dots on sides of body—MABUYA MULTIFASCIATA (Kuhl).
- c² Scales smooth.
  - d¹ Legs well developed, pentadactyl.
    - e¹ No supranasals.
      - f¹ Prenal scales enlarged.
        - g¹ No enlarged nuchal scales present; brown color; terrestrial.
          - h¹ Form diminutive; length about 75 mm. No distinct lateral stripes; uniform light brown—SPHENOMORPHUS STEEREI Stejneger.
          - h² Form small; length about 110 mm.; distinct lateral stripe—SPHENOMORPHUS CURTIROSTRIS Taylor.
          - h³ Size large; length 250mm.; broken lateral dark line present or absent—SPHENOMORPHUS JAGORI JAGORI (Peters).
        - g² Nuchal scales present; small size; length 110 mm. A median golden line; arboreal—LEIOLEPISMA PULCHELLUM Gray.
      - f² Preanals not enlarged; arboreal; reaching a length of 270 mm.—DASIA SMARAGDINUM (Lesson).
    - e² Supranasals present; a large species attaining a length of 360 mm. Large spots on sides in a longitudinal row—OTOSAURUS CUMINGII Gray.
  - d² Limbs pentadactyl, poorly developed; digits very small; scales hard, shiny; a burrowing form—BRACHYMELES BOULENGERI Taylor.
  - d³ Limbs minute, without digits—BRACHYMELES BONITÆ Duméril and Bibron.
- c³ Scales with a single heavy keel; semi-aquatic skinks; length 190—TROPIDOPHORUS GRAYI Günther.

Family GEKKONIDÆ

Gymnodactylus philippinicus Steindachner.

Occurs in the forest under logs, and under loose bark of trees. It is, so far as I know, never found in houses. It may be easily distinguished from other geckoes by the long slender digits terminating in sharp claws, and in the absence of adhesive laminæ under the toes.

Hemidactylus garnotii Duméril and Bibron.

A rare species of house gecko. Only one specimen collected.

Hemidactylus frenatus Duméril and Bibron.

Common in the houses and in lowland forest. Many specimens collected. This species is the one most frequently found in the houses.

Cosymbotus platyurus (Schneider).

A common house gecko. It is rarely if ever found in the forest. It may be easily distinguished by the loose flap of skin along the sides of abdomen. Many specimens collected.

Peropus mutilatus (Wiegmann).

A common gecko found in houses. It is also coı mon in lowland forest. Many specimens collected.

Gekko gecko (Linnæus)

The call of this large gecko may be heard in the forest at low elevations, and not infrequently in the houses. It is widely known in the Philippine dialects as *to-co* or *tuk-ko*. It is probably confined to the lowlands everywhere in the Philippines. Many collected.

Family AGAMIDÆ

Draco spilopterus (Wiegmann).

This species of flying lizard is not rare in the lowland forest. I collected several specimens in the trees near the nursery of the Forest School. So far as is known it is the only species of *Draco* on Mount Makiling. Males and females differ considerably in color and markings. Many collected.

Calotes marmoratus (Gray).

This species has been collected several times about the base of Mount Makiling. Nowhere does it seem common. It is usually found in trees or shrubs, rarely descending to the ground. The usual color is bright green. However, color changes are made with great rapidity, and a bright green specimen may become a dull brown in a few minutes. Males and females differ in the height of the dorsal spiny crest.

Family VARINIDÆ

Varanus salvator (Laurenti).

This large *bayawak* is common on Mount Makiling at low elevation. It is a widely distributed form. Only a few specimens have been collected, although numerous specimens have been observed. It is not improbable that more than one species occurs.

Family SCINCIDÆ

Mabuya multicarinata (Gray).

This species is a very common ground lizard. It occurs up to an elevation of at least 1200 meters. It may be distinguished from the following species of *Mabuya* by its brilliant iridescent coloring and by the yellow or cream stripe on the side of head and body.

Mabuya multifasciata (Kuhl).

This species is common only at low elevations. I have not collected it above 300 meters. It rarely if ever climbs trees. Many specimens taken.

Sphenomorphus jagori jagori (Peters).

Species of this genus differ from *Mabuya* in the absence of keels on the scales. The typical form of this species is found on the mountain usually along the streams or under logs in the forest. It occurs up to an elevation of 1000 meters. It is very much larger than the two following species of the genus. It is not improbable that two forms of this species occur on the mountain. Many specimens taken.

Sphenomorphus curtirostris Taylor.

This small species is not rare on the lower third of the mountain. I have collected it most frequently along mountain streams. The specimens rarely exceed a length of 110 millimeters. There are usually two dark stripes present along the sides. Many specimens collected.

Sphenomorphus steerei Stejneger.

This diminutive form is common at low elevations. It is found in the forest under leaves and along the streams. I collected a large series of specimens in a dry gully near Camp Eldridge during April and May. This species rarely exceeds a length of 70 millimeters.

Otosaurus cumingi Gray.

This is the largest skink found in the Philippines. It resembles *Sphenomorphus jagori* but the lateral stripe is broken into large spots. It runs through the forest making much noise and very rarely ascends trees. It appears to live in burrows. I have collected one specimen along the trail above the Forest School and have observed others near Los Baños.

Dasia smaragdinum (Lesson).

This species is common in coconut trees in the lowlands about the base of mountain and in forest low on the mountain. Its green color and slow deliberate movements on tree trunks makes it conspicuous. It attains a length of 200 millimeters. Many specimens collected.

Leiolepisma pulchellum (Gray).

This diminutive tree skink is not rare in low forest. The brilliant golden or cream line along the middle of the back makes it rather conspicuous in spite of its small size. It is usually found moving about on the trunks of large trees within two or three meters of the ground. Many specimens collected.

Tropidophorus grayi Günther.

This large skink, having extremely rough spiny scales over the entire dorsal surface, is common along the streams. It is usually found under partly submerged rocks or logs. Specimens are usually dull, dirty brown. The young have dull light bars on the back. Many specimens taken.

Brachymeles boulengeri Taylor.

This species is found usually in the forest under rotting logs or trash collected about the base of trees. It is a burrowing form. The shiny, smooth scales, and the short limbs make the species easily recognized. Several specimens taken.

Brachymeles bonitæ Duméril and Bibron.

A single specimen of this species was taken under a rock near the waterfall above Los Baños. It is a rare, burrowing species, without digits on the very diminutive limbs.

SNAKES

Key to snakes known from Mount Makiling

a¹ Teeth in upper jaw only. Small worm-like burrowing snakes with eye concealed under a scale (Family TYPHLOPIDÆ).

b¹ Dimunitive form, uniform gray or brown. Length about 185 mm. (Smallest species)—TYPHLOPS BRAMINUS (Daudin.)

b² Larger form reaching a length of 250 mm.

c¹ Nasal scale completely divided—TYPHLOPS LUZONENSIS Taylor.

c² Nasal scale not completely divided; black above reddish below—TYPHLOPS RUBER Boettger.

a² Teeth in both jaws.

b¹ Vestiges of hind limbs, very large snakes reaching a length of 9 meters (Family BOIDÆ)—PYTHON RETICULATUS (Schneider)

b² No vestiges of hind limbs (Family NATRICIDÆ).

c¹ Head covered with numerous small scales; no widened scales on belly; aquatic—CHERSYDRUS GRANULATUS (Schneider).

c² Head covered with large regular plates. Ventral scales on belly widened.

d¹ No fangs or enlarged grooved teeth in upper jaws. Non-poisonous.

e¹ Scales in 25 rows. Large, green or bluish green snake reaching a length of two meters—GONYOSOMA OXYCEPHALUM (Boie).

e² Scales in 21 rows. Large brownish snake reaching a length of one and one-fourth meters—ELAPHE ERYTHRURA (Duméril and Bibron).

e³ Scales in 19 rows.

f¹ Scales keeled; belly with numerous irregular rows of black dots—NATRIX SPILOGASTER (Boie).

f² Scales keeled; belly with a single row of black dots on outer edges of ventral scales—NATRIX BARBOURI Taylor.

e⁴ Scales in 17 rows.

f¹ Slender, elongate snake with upper surface transversed by about 80 dark bands—HAPLONODON PHILIPPINENSIS Griffin.

f² Short snake, rather dull brown in color; belly with numerous black triangular spots—CYCLOCORUS LINEATUS (Reinharat).

f³ Short, moderately stout snake, usually lavender or brownish purple with a light reticulation, and a more or less definite neck band—LYCODON AULICUS (Linnæus).

f⁴ A short, stout species, the body traversed by eighten to twenty dark purplish spots usually edged with black; belly usually pinkish—HOLARCHUS ANCORUS (Girard).

f⁵ A short, slender, reddish-brown species with a few small, scattered, black spots on the anterior fourth of body; belly pink to orange—HOLOCHERRUM PHILIPPINUM Günther.

e⁵ Scales in 16 rows. A large snake reaching a length of about one and one half meters. (The only Luzon species having an even number of scale rows)—ZAOCYS LUZONENSIS Günther.

e⁶ Scales in 15 rows.

f¹ A slender greenish snake, the skin between the scales blue; arboreal; median scale row enlarged—DENDROPHIS PICTUS (Gmelin).

f² A small snake with a series of large whitish bands disappearing in adult.—OXYRHABDIUM SP.

e⁷ Scales in 13 rows.

f¹ An arboreal snake, the median scale row not enlarged; greenish with distinct longitudinal black lines on the posterior part of the body—DENDRELAPHIS TERRIFICUS (Peters).

f² A very small, burrowing species reaching a length of about 265 mm.—CALAMARIA GERVAISII Duméril and Bibron.

d² No fangs, but enlarged grooved teeth present in the posterior part of maxilla; slightly poisonous but not dangerous.

e¹ Scales in 15 rows.

f¹ A very slender, grayish snake peppered over with minute black dots; arboreal—DRYOPHIOPS PHILIPPINA Boulenger.

f² Slender green snake with a white line on each side of the belly. Head very long (*Dahon palay*)—DRYOPHIS PREOCULARIS Taylor.

f³ Long slender gray or buff colored snake very similar to preceding species—DRYOPHIS GRISEUS Taylor.

e² Scales in 17 rows.

f¹ Slender elongated tree snakes, with a row of reddish flower-shaped spots along the middle of back; apical pits present in each dorsal scale—CRYSOPELEA ORNATA (Shaw).

f² Short, gray, mottled species, semi-arboreal—PSAMMODYNASTES PULVERULENTUS (Boie).

f[3] Scales in 19-25 rows.

g[1] Scales in 19 rows; black, with 80-90 cream or white rings—BOIGA DENDROPHILA DIVERGENS Taylor.

g[2] Scales in 21 rows; yellow-brown with indefinite dark blotches; a long, extremely slender snake —BOIGA ANGULATA (Peters).

g[3] Scales in 25 rows. A large form usually with a series of large brown blotches on the upper part of the body; buff forms without spots are sometimes found—BOIGA CYNODON (Boie)

d[3] Enlarged fangs in the anterior part of maxilla. Deadly poisonous. (Family ELAPIDÆ).

e[1] Scales in 15 rows. Large snakes reaching a length of four meters (king cobra)—NAJA HANNAH (Cantor).

e[2] Scales in 21 rows. Reaching a length of a little more than one meter—NAJA NAJA PHILIPPINENSIS Taylor.

c[4] Head large, triangular, covered with numerous small scales (Family CROTALIDÆ). Large fangs present. Tail short. Usually green with or without brown spots—TRIMERESURUS FLAVOMACULATUS (Gray).

Family TYPHLOPIDÆ

Typhlops braminus (Daudin).

This small burrowing snake is found in the lowlands, usually in the earth or under logs. It rarely attains a length of more than 150 mm. It is usually known as *odto-odto* or by some variant. A few specimens collected.

Typhlops luzonensis Taylor.

A single specimen, the type, was collected on the mountain above the Forest School.

Typhlops ruber Boettger.

One specimen of this rare species was collected at an elevation 600 meters under a small decaying log. The species is usually bronzy-black above and reddish brown on sides and belly. The tail is broader than long and is of greater diameter than the head.

Family BOIDÆ

Python reticulatus (Schneider).

I have collected no specimens. There are, however, specimens present in the College of Agriculture collection and in that of the Forest School. This species is usually known as *sawa*. It attains a length of about thirty feet.

Family NATRICIDÆ

Chersydrus granulatus (Schneider).

This species is confined to Laguna de Bay and small streams which empty into it. An aquatic snake distinguished by the absence of broad ventral scales. Adults are dirty lead color, sometimes showing dull white spots.

Natrix spilogaster (Boie).

This species is found in the lowlands; it probably does not extend up to any considerable elevation on the mountain. It is a common snake usually known as *ahas palaking*. Several specimens taken.

Natrix barbouri Taylor.

A single young specimen which I have identified as belonging to this species is in the collection of the College of Agriculture. It may be distinguished from the preceding species by its having a single row of dots on the outer part of the ventral scales instead of several irregular rows. Probably very rare.

Cyclocorus lineatus (Reinhardt).

A short dark snake with triangular black spots on the belly. It is usually found under logs or under leaves in the forest. It is a ground species, never entering the trees. A few specimens taken.

Oxyrhabdium leporinum (Günther).

Two specimens of this rare species have been found. The young are dark and have white bands; the adults are a dull uniform blue. Medium sized specimens show traces of the light bands. One specimen was taken at an elevation of 780 meters.

Haplonodon philippinensis Griffin.

A single specimen of this rare species was taken on the mountain. It is an arboreal species with a large number of irregular brown spots separated by narrow, lighter interspaces.

Lycodon aulicus (Linnæus).

Several specimens have been collected on the grounds of the Agriculture College. It is often found in houses. It is commonly known as *ahas tolog*. It is not rare. In my work on Philippine snakes it is referred to the genus *Ophites*.

Holarchus ancorus (Girard).

There are specimens of this ground species in the collection of the College of Agriculture taken, presumably, at low elevation. The species is usually of lavender color with dark purple, or black spots on the back. There is an anchor-shaped mark on the head.

Dendrophis pictus (Gmelin).

This slender, green, arboreal species is common at low elevations. It may be easily distinguished from the following species by the absence of dorsal and lateral stripes on body and tail and fifteen instead of thirteen scale rows around the body.

Dendrelaphis terrificus (Peters).

This arboreal species has been collected along the small gully back of Camp Eldridge. There are also specimens in the College of Agriculture collection. The species resembles the preceding species, but it has several stripes which are absent in *Dendrophis pictus*. A few specimens taken. Not rare.

Gonyosoma oxycephalum (Boie).

This large, green, arboreal species reaches a length of two meters. Several specimens are in the collections of the Forest School and College of Agriculture. Four specimens are in my collection. It probably occurs up to the summit of Mount Makiling.

Elaphe erythrura (Duméril and Bibron).

This species is common in the lowlands. It is a terrestrial form and it is frequently confused with the cobras. It is of drab-brown or reddish-brown color. It is entirely harmless, and feeds on small mammals. Several specimens collected.

Zaocys luzonensis Günther.

A single adult specimen of this large species was collected during 1921 by a student of the Forest School. This species is extremely rare, only about half a dozen specimens being known. It differs from *Elaphe erythrura* in having the posterior fourth of the body and tail blackish in color, or blackish, with small yellow-brown spots on most of the caudal scales.

Calamaria gervaisii Duméril and Bibron.

Several specimens of this small burrowing form have been collected at the College. It is sometimes called *ahas-na-cuyog*.

Hologherrum philippinum Günther.

I collected a specimen of this rare species on the mountain above Los Baños. It was found curled under a log in a moist place. It is reddish to reddish brown above, with a few scattered spots on the anterior part of the body. The belly is usually a bright orange. A terrestrial form.

Dryophiops philippina Boulenger.

Several specimens of this slender, inconspicuous snake have been collected. It is strictly arboreal in habit. The color is drab to gray with numerous minute black dots usually present on the dorsal surface. Not rare.

Crysopelea ornata (Shaw)

Several specimens of this arboreal snake have been collected. There is usually a series of flower-shaped red spots present on the median line of the body by which it may be easily distinguished.

Dryophis præocularis Taylor.

This slender green snake known as the *dahon palay* is not uncommon. It is not deadly poisonous as is commonly supposed, although some poison is probably present.

Dryophis griseus Taylor.

This gray species is similar to the former species but appears to be specifically distinct. It is an arboreal form. One specimen taken.

Psammodynastes pulverulentus (Boie).

A single specimen of this species has been collected on Mount Makiling. The color varies from gray to brown with indistinct markings. It is probably rare on the mountain. It is a small semi-arboreal form.

Boiga dendrophila divergens Taylor.

One specimen was collected in the forest near the Forest School nursery. It is a tree or bush species apparently rare on the mountain. The color is black or grayish black with very numerous yellow bands.

Boiga angulata Peters.

A long, slender, arboreal snake, mottled grayish in color. A single specimen taken.

Boiga cynodon (Boie).

Two young specimens were presented to me by Mr. Otto Pflueger, In-charge of the Forest School. They were collected on the mountain sides, but the elevation at which they were found was not recorded. The species is a large arboreal form reaching a length of two meters. Probably rare.

Family ELAPIDÆ

Naja naja philippinensis Taylor.

There are specimens of this cobra in the collection of both the Forest School and the College of Agriculture. I have not collected it. The species attains a length of about one to one and one-half meters. It is deadly poisonous. Not rare.

Naja hannah (Cantor).

A number of specimens of the king cobra has been collected in or near the campus of the College of Agriculture and the Forest School nursery. The species reaches a length of more than four meters. It may be distinguished by the presence of two large post-parietal scales, which are absent or very small in *Naja naja philippinensis*. Deadly poisonous.

Hemibungarus calligaster (Wiegmann).

This small species is conspicuous by the red (or yellow) and black markings on the belly. It is a burrowing form. Its bite is poisonous, not improbably resulting in the death of the individual bitten. Many specimens have been collected on the Agricultural College farm. Young and adult vary greatly in color.

Family CROTALIDÆ

Trimeresurus flavomaculatus (Gray).

This green viper probably never attains a length of more than one meter. Its bite is poisonous usually resulting in death. Some specimens have a row of irregular brown spots along the back. The large head, covered with very numerous small scales, distinguishes this species.

ADDENDUM

Since this paper has gone to press I have obtained a few species not included on this list. The lot includes three unidentified frogs belonging to the genera *Rana*, *Polypedates* and *Cornufer*; one lizard *Gonyocephalus bitorques*, Peters.

ANÆSTHESIA IN PLANTS[1]

By D. A. Herbert

Of the Department of Plant Physiology

Anaesthetics are defined as those substances which act on living cells in such a way as to abolish temporarily those activities which we regard as manifestations of life (1). The effect of chloroform, ether, and other anæsthetics on plants at first sight appears analogous with that produced in animal tissues, and on this account the term anæsthetization is a term commonly used in descriptions of effects of these substances on vegetable life. In the following experiments, however, proof is advanced of the absence of such an action, and the effects are shown to be produced by one of two causes,—either shock stimulus or injury stimulus.

Mimosa pudica was the plant chosen for the experiments as it shows response to stimuli with extreme rapidity and also to a greater degree than any other plant. Its common occurrence as a weed was an advantage, as hundreds of plants were available for the experiments. A great deal of work on this plant has already been performed, but owing to the fact that no quantitative examinations on the effect of stimulus have been published, it was found necessary to study in detail the effects of various stimuli before proceeding with the study of effects of anaesthetics.

Haberlandt (2) has shown that transmission of stimulus takes place through tubular cells in the phloem, which possess fine pores in their walls. Removal of the cortical tissue by Dutrochet, an early worker, showed that the remaining part was still capable of transmitting, but this was shown by Haberlandt to be due to the incomplete removal of the phloem; some of the tubular conducting cells still remained intact. This removal of all the tissue external to the wood is a difficult matter owing to the structure of the vascular bundle in traverse section, and unless a good deal of the wood is removed at the same time it can not be assumed with certainty that all the tubular cells have been removed. Haberlandt's theory has been questioned by Jost (3) and in order to test its truth a number of experiments were performed and repeated again and again so that possibility of accidental inaccuracies was reduced to a minimum. In most cases about twenty-five plants were used for each experiment.

When a stem or a petiole is cut a drop of liquid appears almost immediately on both surfaces. In the case of the petiole this occurs to the same extent whether the leaf is erect or relaxed, and its appearance is too rapid to snow from which region exudation has taken place. If this first drop is removed quickly, however, the next forms only slowly and with a hand lens it can be seen that the liquid emerges from the cells in the phloem region. This liquid contains a large amount of non-crystalline solid in solution and if the drop is allowed to remain on the end of the cut stem or petiole it evaporates and forms a fairly effective plug which prevents further bleeding. The turgidity in these cells must be a necessary condition for the transmission of stimulus. An increase of pressure at one end of

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[1] Experiment Station Contribution No. 102.

such a system (for example, at the primary articualtion) must be transferred to the other (following the same example, the secondary articulation). If the tubular cells have their turgidity destroyed by "ringing" the petiole with a sharp razor well into the xylem so that they are all cut, no transmission takes place when either end of the petiole is stimulated. Owing to the poor transmission in the stem when proper precautions are observed, all the following experiments were carried out on the petiole, which is much more suitable because it shows response more markedly.

The decortication method of Dutrochet was tried, but to ensure the complete removal of all tubular cells the petiole had to be whittled until a large amount of the xylem also had been removed. It was found that if the removal of these tubular cells was complete there was no transmission at all. The same result was found when they were all cut by ringing the petiole with a razor. Leaflets might be scorched or cut, and yet the primary pulvinus did not fall; conversely the primary pulvinus might be stimulated. The absence of transmission in the xylem would not be proved by experiments where the petiole was dexylified, because it would only prove whether or not the tissues external to it were active in this respect, and not that the wood was inactive. Dexylification is a much more certain operation than removal of the tubular cells. In petioles so treated it was shown that the rate of transmission was practically as rapid as in a normal leaf. It may be noted here that the removal of the wood in the petiole of the sensitive plant causes a permanent closing of the leaf in a short time, and in order to avoid this and bring about the erection of the leaf after the excitatory fall during the operation, the cavity where the wood had been was kept filled with water. This method was very effective.

More simple than this method of removal of tissue is the method of cutting it through with a sharp razor. Mention has already been made to the effect of cutting through the tubular cells, and to the fact that if a few are left uninjured transmission still takes place. If the petiole, therefore, is cut through just far enough to cut all the wood, a few tubular vessels will remain on the uncut side. Such a petiole was found capable of practically normal transmission. A somewhat deeper cut will sever all the tubular cells while leaving part of the cortex still intact. In this case it was found that there was absolutely no transmission. In a number of cases where transmission did occur after the operation, a section of the petiole showed that the cut had not been made deep enough, so that this was not conflicting evidence. It is evident that such an operation cannot be reduced to a state of microscopic accuracy, but sections can be made after the transmission test has been performed, and the actual extent of the cut determined.

These facts, therefore, support Haberlandt's theory of transmission. In some of the experiments described below it was necessary to clamp the petiole of the leaf firmly; in these cases, bearing in mind the means of transmission, it was necessary, therefore, to guard against producing a ligature effect.

A considerable amount of data on the response of *Mimosa* to various stimuli has been collected by Bose (4), and he has put the wrong interpretation on a number of the experiments, and in others dealt only with the more obvious appearances and jumped at conclusions. In the experiments to be described the following stimuli were studied: mechanical shock, wounding, heat, and various gases (including anæsthetics).

MECHANICAL SHOCK

The effect of a mechanical shock varies with its intensity. If the terminal leaflets are struck they close, and if shock is sufficient the primary pulvinus, as well as the secondary and tertiary ones are stimulated and the whole leaf assumes the sleep position. The mechanism of this is sufficient to show that here we are *not dealing with a case of transmission of stimulus*. In the experiments to be described below the normal course in undoubted cases of transmission of stimulus the leaflets close first on the pinna affected, and then the other pinnae droop and their leaflets close; finally the primary pulvinus is affected and the petiole then droops. The action in the case of a struck leaf is not transmission of stimulus but is due to the fact that the stimulus is spread over the whole of the parts affected; in this case the petiole is shaken. When the petiole is so fixed that the pinnae can be struck without the petiole being shaken no movement occurs in the primary pulvinus. Similarly when the primary pulvinus is struck the rest of the leaf is unaffected. In the same way if the middle of one of the pinnae is fastened firmly, the rest of the leaf may be struck violently without transmission whatever to the part beyond the clamp; and *vice versa*.

WOUNDING

The only precaution to be observed on the study of wound stimulus is the avoiding of shaking of the leaf or the stem. This may be avoided with certainty by clamping the parts firmly, but at the same time not tightly enough to produce a ligature effect. When the wound is made by cutting or pricking, an exitatory fall takes place in the leaf, and the stimulus is transmitted beyond the clamp. If the stem is operated on, the neighboring leaves are affected; generally the lower one falls first, then the upper, and sometimes others further along the stem or the petiole, also respond. If, however, a ligature is made round the stem or the petiole, as the case may be, the stimulus is not transmitted beyond it.

The rate of recovery after wound stimulus is much slower than that of a leaf which has fallen from mechanical shock, as the following table shows:

TABLE 1.—*Time of complete recovery in minutes*

Wounded	17	21	17	29	20	19	20	20	21	20
Struck	10	10	11	8	8	10	11	12	11	10

The time of recovery of leaves indirectly affected by the wounding, i.e. the leaf above or below which showed an excitatory fall, was the same as that of which had been mechanically stimulated.

TABLE 2.—*Time of complete recovery in minutes*

Struck	10	9	9	11	9	9	10	9	11	9
Indirectly affected by wounding	9	10	10	9	9	11	10	8	9	9

These readings are typical of some fifty that were made. Obviously the effect of a wound is much more profound than that produced by a blow. The pressure in the tubular cells has been reduced, so this is to be expected.

With regard to the intensity of the stimulus it may be remarked that the more violent the wounding, the more rapid the transmission. Mere cutting of the terminal leaflets may, for instance, result in a closing of the leaflets in one minute followed by the fall of the petiole a fraction of a minute later. Cutting of a pinna, however, results in an extremely rapid fall of the main pulvinus and an actual relative delay in the fall of all the pinnae. Some of the figures observed are as follows:

TABLE 3.—*Rate of response and recovery of injured leaves.*

	Time of fall of all the pinnae.	Time of fall of primary pulvinus.	Time of complete opening of all the leaflets	Time of complete erection of primary pulvinus.
Leaflets only cut.	60 seconds	94 seconds	600 seconds	360 seconds
	60 "	94 "	600 "	360 "
	60 "	80 "	420 "	880 "
Pinna cut.	1 second	8 seconds	420 seconds	300 seconds
	1 "	10 "	360 "	300 "
	2 seconds	10 "	420 "	300 "
	2 "	1 "	780 "	660 "
	2 "	1 "	840 "	720 "
	3 "	4 "	420 "	300 "
	3 "	1 "	360 "	300 "
	3 "	1 "	360 "	300 "
	4 "	3 "	542 "	421 "
	4 "	2 "	400 "	303 "
	5 "	3 "	480 "	421 "

These readings were all taken at the same time on the same day so that the plants would be under similar atmospheric conditions. In the case of more violent wounding the stimulus is transmitted down the petiole to the primary pulvinus before the other pinnae are affected. It appears as if when such a stimulus is transferred it has not time to sidetrack to any great extent into the other pinnae before it has reached the primary pulvinus. If however it is weaker it passes into the pinnae along the side branches of the transmission channels as rapidly as it does down the direct route of the petiole.

HEAT

The effects of heat on *Mimosa pudica* come under two headings, first, heat shock, and second, heat injury.

If the heat is applied gently so that the leaves are not scorched, an excitatory fall is produced, resembling in all respects that produced by mechanical shock. The temperature itself is not the only deciding factor, but the action is also influenced by the atmospheric conditions and the rate at which the heat is applied. If the heating is done by means of a lens the fall is restricted to the leaf heated, but if a candle is used a fall is frequently produced in neighboring leaves. This is due not to transmission, but to the radiation of the heat to the others, in the same way that the fall of a number of leaves when one is struck is due to the shaking being spread over a larger space than that occupied by the single leaf.

If, however, the heat is sufficient to cause actual injury to the leaflets being stimulated, then the results are comparable with those produced by wounding. The temperature which will cause injury varies with individual plants but in normal cases varies between 60° and 70 C.

GASES (INCLUDING ANÆSTHETICS)

Bose has studied the effects of various gases on the irritability of *Mimosa pudica*, using for the purpose his Resonant Recorder, but has not considered it from a quantitative point of view, and further adopts the generally-held view that the action is narcotic in some cases. Quantitative experiments are extremely difficult, but even the degree of accuracy which can be attained is sufficient to show that the action is not narcotic. Chloroform, ether, and ammonia are the gases said to act in this way; three others, hydrogen sulphide, nitrogen dioxide, and sulphur dioxide, which are regarded as undoubted poisons, were also studied.

Chloroform. Everything depends on the amount of stimulation of the leaf. Chloroform gas blown on to the leaf causes a fall of the same type as produced by mechanical shock. In Bose's experiments the gas was introduced into a chamber in which the *Mimosa* plant was confined. Under such conditions the effect is continuous, and there is great danger of injury being produced by the prolonged exposure. If, however, the gas is very dilute recovery takes place even in its presence, thus showing that the initial response was due to the effect of shock. Prolonged exposure to the dilute vapour of chloroform or the spraying of the leaves with chloroform with an atomizer gives the same result,—a fall comparable to that produced by a wound. There is no transmission when the amount of chloroform used is sufficiently small to produce no injury to the tissues. It is necessary to provide the treated portion of the leaf with a shield which will prevent diffusion of the gas to other parts of the plant. When this precaution is observed there is not only no transmission to other leaves, but none to the part of the treated leaf beyond the shield. As soon as injury is produced, however, the rest of the leaf falls. The effect may be felt by the others above and below it on the stem.

The mechanism of the fall with excess of chloroform is similar to that produced by wounding. A relatively weak injury stimulus results in the fall of the pinnae before the primary pulvinus is affected and a stronger one in the fall of the primary pulvinus before the pinnae which have not been stimulated begin to close.

In the following table the chloroform was blown on to one pinna of each leaf in a fine spray and was almost immediately removed by evaporation so that the additive effect of continuous stimulus was eliminated.

An experiment as quantitative as possible was made by regulating the amount of chloroform sprayed on to a pinna, and the time of recovery noted. The whole of the amount sprayed does not of course reach the leaflets, some being lost through evaporation and some passing between them or past their edges. A control experiment where the leaves were treated with enough chloroform to cause a fall but no injury was also made, and a comparison of the results is shown in the following table. The times are in minutes and the figures in the horizontal columns are naturally not obtained from the same leaves.

TABLE 4.—*Rate of response of leaves treated with chloroform.*

	Time of closing of all the leaflets.	Time of fall of primary pulvinus.
Sprayed with a trace of chloroform	36 seconds	60 seconds
	27 "	30 "
	36 "	60 "
	36 "	60 "
	26 "	28 "
	26 "	28 "
Sprayed with enough chloroform to produce an injury stimulus	2 seconds	2 seconds
	3 "	2 "
	3 "	2 "
	3 "	1 "
	4 "	1 "
	8 "	5 "

TABLE 5.—*Rate of recovery of leaves treated with different amounts of chloroform.*

Control.	Amount of chloroform.				
	3 c.c.	6 c.c.	.9 c.c.	1.2 c.c.	1.5 c.c.
15 minutes	65 minutes	98 minutes	Recovery incomplete	No recovery	No recovery
15 "	65 "	98 "			
15 "	66 "	99 "			
16 "	66 "	99 "			
16 "	67 "	99 "			

The leaflets on the pinnae treated with .9 cc. only recovered to the extent of opening about half-way; this was accomplished in slightly less than two hours. From these figures it will be seen that the amount of response in *Mimosa pudica* stimulated with chloroform depends on the amount of stimulus and that the results may be compared to the cases of mechanical shock and wounding. Wounding bears the same relation to mechanical shock as injury by chloroform does to simple chloroform stimulation without actual injury.

The question to be decided is whether or not chloroform acts as an anaesthetic. Bose, who has added as much to the knowledge of the irritability of *Mimosa pudica*, does not agree with Haberlandt's theory of the hydromechanical transmission of impulse, and concludes that "transmission effect could only be due to propagation of excitatory protoplasmic change" (page 159). On this assumption he concludes that the action of chloroform is narcotic, and compares the transmission of stimulus through chloroformed tissue with transmission through the nerve in a frog's sartorius which has been rigored by dipping in warm oil. He quotes Biedermann as saying that the half which remained normal twitched on cutting the rigored portion with scissors, showing that excitable nerve fibres could still be mechanically excited between the rigored and the dead muscle fibres. This is paralleled with the transference of stimulus which takes place through a chloroformed or scalded leaf, the stimulus being conveyed just as well when the leaf is chloroformed or scalded as when it is in the normal condition.

It may be pointed out here that this transmission occurs in the same way when the leaf has fallen through mechanical shock, and so the properties of

a leaf as far as transmission is concerned are in no way different in the two cases. We must therefore either assume that all relaxation in *Mimosa* is narcotization whether caused by wounding, shock, mechanical stimulus, or stimulus by substances which are animal narcotics, or else we must assume that there is no narcotization at all.

The latter view is supported by the work of Brown (5) who confirmed Pfeffer's conclusion "that the movement of the living pulvini is due to changes in the osmotic pressure of the cells of the reacting half, and shown that movement in the pulvini can take place without the aid of any vital phenomena." The elimination of vital phenomena dismisses Bose's theory of transmission by propagation of excitatory protoplasmic change, and with it the possibility of narcotization.

The final proof of non-anaesthetization is shown by the fact that if *Mimosa pudica* plants be placed under a bell jar to which small amounts of chloroform gas are introduced an excitatory fall is produced. If the chloroform is left in contact with the leaves, they will recover in the same length of time which it would take a mechanically stimulated leaf to resume its normal position. If, however, the amount of gas be increased a prolonged fall is produced, and the plant does not recover till the chloroform is removed. Even then recovery is not complete; the difference is therefore due to the fact that injury stimulus has been produced. In the first type the fall has taken place because of the *sudden* change of conditions. If anaesthesia had taken place recovery would of course not be effected until the exciting agent had been removed.

Effects of other gases.—The effects of other gases, ammonia, hydrogen sulphide and sulphur dioxide are similar to those of chloroform but they differ in degree. Ether has very much the same effect, but the other three are more toxic, and cause death to the *Mimosa* leaves in much greater dilution than do chloroform and ether. If these gases are applied in sufficiently small amount to a pinna which is effectively screened from the other pinnae a fall similar in all respects to that produced by mechanical shock takes place and is not transmitted beyond the screen. In greater amounts the effect is similar to that produced by a mechanical injury and may be transmitted first to the primary pulvinus, then to the other pinnae and often to neighboring leaves.

The stimuli that produce an excitatory fall in Mimosa may, therefore, be classified into two types, first, simple response, and second, injury stimulus. The first is typified by the action of mechanical shock, where the stimulus is too feeble to produce appreciable transmission. A similar response is found where the leaves are subjected to a chemical stimulus regulated so that no injury is produced, and where leaves have been affected by transmission of a stronger stimulus though not directly stimulated. The second type is produced by injury which may take the form of cutting or of heating or of chemical stimuli.

Evidences against the narcotization of Mimosa by chloroform and ether are afforded from four points of view:

1. In small quantities they produced the first type,—simple response. In larger quantities they produce effects similar to those produced by undoubted plant poisons, such as hydrogen sulphide, sulphur dioxide and ammonia.

2. Transmission takes place through relaxed leaves subjected to a strong stimulus, whether the original stimulus was due to mechanical shock or the action of other "simple stimuli".

3. Transmission is not due to "propagation of excitatory protoplasmic change," so that narcotization can not take place.

4. Recovery takes place when the "anaesthetic" is in amounts small enough not to cause injury, even though the gas be still present.

Support to the theory that substances capable of causing anaesthesia in animal cells do not cause anaesthesia in plants, but rather effects similar to those produced by ordinary poisons is lent by the work of A. R. C. Haas (6) on *Laminaria*. He found that an anaesthetic, if used in "sufficient concentration," promotes an increase in respiration, his results therefore disproving the theory of Verworn that these substances produce a kind of asphyxia. *Mimosa pudica*, being a much more responsive plant than *Laminaria*, is a much better agent for the demonstration of the actual nature of "plant anaesthesia". The results of Haas lend support to the theory advanced above in that the increase in respiration is a phenomenon observed when plants are injured. Further, after the first increase, there is a marked decrease if the reagent is sufficiently toxic while if the amounts are smaller the decrease is much more gradual. These observations therefore fall into line with the theory advanced above.

SUMMARY

1. Experimental support is given to Haberlandt's theory of transmission in *Mimosa pudica*.

2. Stimuli may be divided into two types
   a. Simple response produced by mechanical shock and properly controlled chemical stimuli, etc.
   b. Injury due to mechanical, chemical and other agencies.

3. The first type is too feeble for rapid transmission, but the second is rapidly conducted.

4. Leaves indirectly affected by a transmitted stimulus behave like leaves which have shown simple response.

5. Rate of transmission and time of duration of the effects of the stimulus are directly proportional to the amount of stimulus.

6. Chloroform and ether do not narcotize Mimosa. Their effect is similar to that of more violent poisons such as ammonia, hydrogen sulphide, and sulphur dioxide, but differs in degree. Properly regulated amounts of these substances produce simple response, but in excess they produce an injury stimulus. Anaesthesia is not produced in plants by the use of gases which produce this phenomenon in animals.

7. In the presence of small amounts of these gases an excitatory fall is first produced, but the leaf re-erects itself and the time taken is the same as that in the case of simple stimulus. Where the effect is prolonged it is found that injury has been produced and complete recovery does not take place.

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THE TOXICITY OF IPIL-IPIL (*Leucæna glauca*)

By VALENTE VILLEGAS

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Present day scientists are prone to indulge in ridicule whenever a layman or "old-timer" gives his view on questions requiring controlled means of observation. But Steenbock of the University of Wisconsin was farther visioned when he undertook work to verify the farmer's common saying that yellow corn has a better feeding value than white corn. The writer, having in mind the popular dictum of old horsemen that ipil-ipil or Sta. Elena (*Leucæna glauca*) is the cause of horses' hair falling out, conducted a trial with this end in view and thereby verified an old man's opinion.

About two months ago the case of a beautiful mare and foal came to my attention. This mare and foal were turned loose in a pasture of grass in which was a thick stand of ipil-ipil. These animals were then looking normal with long manes, tails and coats, but rather thin. After a certain length of time they were taken by the owner, and I then enquired into the bare condition of mane and tail. Without hesitation the owner remarked that it was the effect of ipil-ipil feeding. The coat of both animals was normal and both were improved in flesh. A little later two of the College fillies were brought in from a pasture of grass and ipil-ipil, in which they were being kept for sometime, and they had also lost a considerable amount of hair from their manes and tails. These animals were in good condition otherwise. Immediately the veterinary authorities were consulted and parasites were searched for on the mane and tail but only one or so could be located. One of the fillies was given treatment at the veterinary clinic and the other withheld to compare the behavior of the mane and tail on recovery. I already had the suspicion as to the ipil-ipil causing this malady and it so happened that the filly which was let alone grew hair faster and better than the one treated. If any parasites were present certainly the one treated should have shown more improvement than the other. This stimulated my interest into taking up the problem seriously from the standpoint of the belief in the causative action of the ipil-ipil.

On September 2, 1922, a colt was subjected to trial giving him only ipil-ipil in the form of leaves, seeds and tender stems. For about three days this colt would eat nothing but ipil-ipil but later refused to eat this readily and so was allowed to eat grass for roughage with ipil-ipil seeds mixed with rice bran as concentrate. On the sixth day the hair pulled off very readily, but in this case not only on the mane and tail, but also all over the body including the extremities. Before the trial the writer tries to pull off the hairs of mane and tail as well as of the body but to no avail. This wholesale shedding off of hair in this particular subject, the writer suggests, may be due to the fact that the animal has been more intensively fed or "drugged" on ipil-ipil.

To my mind this particular mode of behavior of ipil-ipil is interesting not only from the standpoint of its effect on horses but also from that on other

[1] Experiment Station Contribution No. 101

classes of livestock which may likewise be affected. It would also be interesting to find out any effect this feed has on other functional activities of the animal body. Finally in the event of the isolation of the causative principle in question the ipil-ipil may become a commercial source for the concoction of certain preparations in pharmacology.

The writer has plans to carry out further more elaborate research into the effect of the pilipil on the hair of horses and it is hoped that other classes of livestock will also be experimented with later on. The feeding of the different parts of the plant to horses to determine the presence and relative amount of the principle in each part would next be in order. Later the Departments of Chemistry and Animal Husbandry may cooperate in ascertaining the actual chemical constituent responsible.

PARASITOLOGICAL STUDIES BY THE USE OF COLLODION SACS IMPLANTED INTRAPERITONEALLY.[1]

I. Notes on the Life-History of *Ascaris lumbricoides*.

By Marcos A. Tubangui, Gregorio San Agustin, and Francisco M. Fronda

Collodion sacs implanted intraperitoneally have afforded a means of cultivating bacteria under conditions approaching the invasion of a host. Due to the semipermeable character of the sacs, the bacteria are in a place where they are able to derive nutritive substances from the peritoneal fluid and at the same time to yield soluble diffusible products which might affect the animal. In the Institute Pasteur, France, this method of investigation enabled Metchnikoff, Roux, and Taurelli-Salimbeni (1) to demonstrate the liberation of a soluble diffusible toxin by the cholera vibrio.

It occurred to us that collodion sacs may serve a useful purpose in parasitological studies. It was believed that their application, if successful, would be of value in the explanation of certain phenomena occurring during the development of certain animal parasites and may also be of aid in the determination of their pathogenicity.

PREPARATION OF COLLODION SACS.

Gates (2) described a method for preparing collodion sacs for use in bacteriology. At first we followed his tecnique, but we decided later that, inasmuch as our purpose does not require strict asepsis as must be observed in bacteriological studies, we could utilize a simpler method. Consequently we prepared our collodion sacs in the following manner, modifying the combinations of Looney (3) in order to obtain as much flexibility and semipermeability as possible and at the same time produce strong sacs.

> 8 gms. of Du Pont's "Parlodion" dried for 24 hours over concentrated sulfuric acid are placed in a clean, dry, amber-colored bottle. 15 cc. of absolute ethyl alcohol, 50 cc. of ether, and 5 cc. of ethyl acetate are added and after vigorous shaking the bottle is allowed to stand. It requires two or more days to completely dissolve the collodion and it is necessary to shake the bottle every now and then. The thick supernatant fluid is then decanted off into another colored bottle and is ready to be used.
>
> A small, perfectly clean and dry test-tube is filled with the collodion solution, which, after a few seconds, is poured back into the container by holding the test-tube at an angle of about 60° and slowly rotating it until the collodion no longer drips freely. The test-tube is now placed between the palms of both hands and rolled moderately fast in an inverted position until the collodion is apparently dry and is then clamped upside down to a stand. When the membrane, which is that portion of the collodion so-

[1] Experiment Station Contribution No 103.

lution which was left adhering to the wall of the test-tube, is completely dry, it is removed by peeling the top from the mouth of the test-tube and then pouring some water between the membrane and the side of the test-tube.

Depending upon the size of the sac desired to be implanted, a certain length of the portion towards the open end of a sac thus prepared is cut off with scissors. After introducing into the remaining portion whatever is to be placed, the open end of the sac is closed by first tying with silk thread and then sealing the stump with collodion solution.

We have usually used sacs about 2.5 cm. by 1 cm. in size. They are introduced into the peritoneal cavities of mammals by making brave incisions on the side of the abdomen while the animal is under complete ether anaesthesia. Two layers of sutures are then placed and the wound is painted with flexible collodion. In the case of chickens the intraperitoneal implantation of collodion sacs is easily accomplished by simply making an incision through the last intervertebral space as is practiced in caponization. We have usually implanted one or two sacs without detecting any uneasiness from our experiment animals.

We have chosen to work first with the eggs of *Ascaris lumbricoides* because of the ease with which they can be cultured and because of their resistance to various chemicals which kill most helminth eggs. Whenever it was desired to free the eggs from contaminating bacteria after they are placed in collodion sacs, we immersed the latter in 1.5% nitric acid solution for 5 or 6 days, which was sufficient in most cases to destroy all forms of microorganisms. The acid was subsequently removed by dializing the contents of the sacs against sterilized tap water several times until the dializate, when tested with litmus paper, was neutral or slightly acid in reaction.

We used in all these experiments eggs obtained from a single female specimen of *Ascaris lumbricoides*. The eggs were cultured and kept in shallow Petri dishes with 2% formalin solution at room temperature.

RESULTS OF EXPERIMENTS

Without going into details on the complete history of the animals used in these experiments, the results which are discussed in this paper may be given as follows:

1. Embryonated eggs of *Ascaris lumbricoides* in semipermeable collodion sacs hatched as early as 20 hours after implantation in the peritoneal cavities of guinea pigs.

Sacs containing eggs contaminated with bacteria contained partially disintegrated larvae, or no larva at all but many empty egg-shells after 6 or more days.

Sacs containing eggs freed from bacteria contained free, active larvae after 3 to 27 days.

2. Impermeable collodion sacs containing *Ascaris* eggs contained very few if any hatched larvae 2 to 4 days after implantation in the peritoneal cavities of guinea pigs.

3. Embryonated *Ascaris* eggs in semipermeable collodion sacs implanted intraperitoneally in dogs and cats hatched in from 1 to 2 days.

4. Semipermeable collodion sacs containing *Ascaris* eggs contained hatched larvae 20 hours after implantation in the peritoneal cavities of chickens. The liberated larvae, however, were dead while the embryos with their shells intact were still alive, showing that the newly hatched larva is more easily killed by higher temperatures. All the unhatched eggs in sacs recovered 2 to 4 days after implantation contained dead, vacuolated embryos.

DISCUSSION

HATCHING OF *ASCARIS* EGGS

The conditions which determine the hatching of *Ascaris* eggs have not been satisfactorily explained. That hatching is not due to an enzymatic action which destroys the coverings of the eggs, is further proved in the present experiments because of the fact that enzymes, if any be present in the peritoneal fluid, being colloidal in nature, cannot reach the eggs through the collodion sacs.

Martin (4) has concluded that three factors are necessary for the liberation of the embryo, viz., (*a*) the complete development of the embryo, (*b*) a surrounding medium that is alkaline or neutral in reaction and (*c*) a temperature that is the same as the temperature of the host of the parasite. According to this author *Ascaris* eggs do not usually hatch in the stomach because of the acid reaction of the contents of this organ. Ransom and Foster (5), however, have found these factors insufficient to account for the hatching of *Ascaris* eggs. Davaine (6), Schwartz (7) and others are of the opinion that hatching takes place as a result of the rupture of the egg-shell due to the increased activity of the enclosed embryo when subjected under the influence of the body temperature of the host.

Our object in implanting collodion sacs filled with embryonated *Ascaris* eggs in the peritoneal cavities of different animals was partly to seek for a possible explanation of the hatching of these eggs. Our results show that they hatched in guinea pigs, dogs, cats and chickens, but only with difficulty in the latter animals. The peritoneal fluids of these animals, as well as the contents of the collodion sacs, when tested, were alkaline in reaction. Their rectal temperatures during the periods of our observations were as follows: guinea pigs, 37.8° to 38.0° C.; dogs, 38.5° to 38.9° C.; cats, 37.7° to 39.5° C.; chickens, 41.8° to 42.3° C.

It would appear, as claimed by Davaine, Martin, and Schwartz, that the body temperature of the host influences to a very important extent the liberation of the embryo. Even in chickens in which hatching was least expected to occur, a small number of embryos were liberated, due apparently to the stimulating effect of the body temperature. In order to test these opinions further and to inquire why hatching seldom takes place *in vitro* even at the temperature of the body, we implanted very thick impermeable collodion sacs containing embryonated *Ascaris* eggs in two guinea pigs. We found that hatching did not occur, at least not as readily as when semipermeable sacs were used. In one of these thick sacs we failed to notice even a single liberated larva and in the other we found only one free but dead larva and one dead embryo with one-half of its body extruding through an opening in the egg-shell.

These observations point to the fact that there are other conditions besides those mentioned by Martin which are responsible for the hatching of *Ascaris* eggs. We suspected that there must be something in the bodies of suitable

animals which aids in the escape of the embryo from its shell or that the embryo itself undergoes certain changes which enable it to break its shell. The second possibility occurred to us more plausible, so that we began to examine very closely newly-hatched larvae obtained from implanted collodion sacs and larvae which were artificially expelled from the eggs by applying pressure. Measurements of twenty-six newly-hatched larvae (1 to 3 days old) showed the following variations in size: 0.227 mm. to 0.257 mm. long by 0.010 mm. to 0.014 mm. thick. Thirty-seven artificially hatched larvae measured 0.215 to 0.249 mm. long by 0.010 to 0.012 mm. thick.

It is rather difficult to draw conclusions from the above figures, because they show very slight differences. Furthermore the variations in size of the newly hatched larvae may be originally due to variations in the size of the eggs; and since there is no way of determining which larvae came from smaller or larger eggs, a very accurate interpretation cannot be given. On the average, however, a newly hatched larva was found to be slightly larger or more active than an artificially expelled larva. Therefore, it may be presumed that when fully developed *Ascaris* eggs are introduced in the body of a suitable animal, the embryos may either undergo a certain amount of growth or become more vigorous and by their more active movements they are able to break the shells. This may be explained by the assumption that certain nutritive substances are able to penetrate the coverings of the eggs and thus reach the embryos. This is possible when eggs are placed in semipermeable collodion sacs; but when they are placed in impermeable sacs nutritive substances cannot diffuse into the eggs.

EFFECT OF BACTERIA ON ASCARIS LARVAE

In four controlled experiments in guinea pigs, it was found that collodion sacs filled with embryonated *Ascaris* eggs, which were freed from bacteria by immersion in 1.5% nitric acid solution for 5 to 6 days, contained free, active larvae when recovered 3 to 27 days after implantation. The contents of such sacs remained clear like water, while the contents of sacs which were not treated with nitric acid solution became pusy in appearance after 6 or more days. In only one instance (in a pup) did we succeed in finding a single free, active larva in a sac containing contaminated *Ascaris* eggs. In all others, we found hatched but partially disintegrated larvae or we found no larva at all but many empty egg-shells when examined 6 to 15 after implantation.

It is apparent from these findings that the newly hatched Ascaris larva is easily killed and disintegrated by bacterial organisms. It may be stated in this connection that Ransom and Cram (8) have observed that *Ascaris* larvae from the lungs 1 mm. or more in length show more resistance to the action of artificial gastric juice than smaller larvae up to 0.8 mm. in length. According to Miyagawa (9) *Ancylostoma* larvae are more resistant to the action of human gastric juice after passing through the lungs than before their passage through these organs. In the light of these observations it may, therefore, be said that *Ascaris* and *Ancylostoma* larvae are better able to withstand unfavorable surroundings as they become more advanced in age; and that the migrations of newly hatched *Ascaris* larvae to the lungs enable them to escape from the injurious effects of the bacteria and digestive fluids present in the intestines.

THE RELATION OF CHICKENS TO THE SPREAD OF *ASCARIS LUMBRICOIDES*

In certain places where chickens are allowed to run at large and where they sometimes gain access to human excrement, it is important to know if these animals, by ingesting the eggs of *Ascaris lumbricoides*, are able to spread the parasite. Ackert (10) has recently determined that hookworm eggs remain viable and hookworm larvae are apparently not injured while passing through the alimentary canal of chickens.

Although our experiments were performed in a different manner from those of Ackert, we believe that our results have a similar bearing in that, as far as we are able to determine at present, the principal factor to be considered is the relation of parasite eggs to the high temperature of chickens. We have found, as stated elsewhere, that a limited number of embryonated *Ascaris* eggs hatched in the peritoneal cavities of chickens, while those which failed to hatch still contained motile embryos 20 hours after implantation. We did not determine whether or not these eggs were still infectious but, judging from the fact that they continued to show motility on being stimulated several hours after they were removed from the chickens, it may be assumed that they would hatch when fed to suitable animals.[1]

In the settlement of this question it is also necessary to consider the length of time during which the eggs have to remain in the body after they are ingested by chickens. According to our observations *Ascaris* embryos are killed in two days when exposed to temperatures between 41.8° and 42.3° C. (body temperatures of chickens). If it takes this much time from the time they are picked up before the eggs are excreted, the danger of chickens spreading viable *Ascaris* eggs is remote. According to Ackert, however, it takes only from two hours and forty minutes to sixteen or more hours for food material to pass through the digestive tract of chickens, in which case there is danger of viable Ascaris eggs being spread by chickens.

SUMMARY

1. Embryonated *Ascaris lumbricoides* eggs in semipermeable collodion sacs hatched as early as 20 hours after implantation in the peritoneal cavities of guinea pigs, dogs, cats and chickens.

2. Temperature is an important factor in the liberation of the embryo. Temperatures between 37.8° and 42.3° C. allow hatching to take place. At 41.8° to 42.3° C., however, newly hatched *Ascaris* larvae do not live long.

3. The hatching of *Ascaris lumbricoides* eggs is due to an active penetration of the egg-shell by the embryo under the influence of the body temperature of the host. Before this can take place, however, it seems necessary that nutritive substances be available in the utilization of which the embryo may increase in size or at least become more active in its movements so as to be able to break its shell.

4. Newly hatched *Ascaris lumbricoides* larvae are very easily killed and disintegrated by bacteria. In the intestines of the host this bacterial action is incidentally avoided by the migrations of the larvae to the lungs.

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[1] We have also observed that *Ascaris eggs* in the early stages of segmentation, which were recovered from sacs implanted for 20 hours in chickens, continued to develop

5. Chickens are apparently able to spread *Ascaris lumbricoides* by ingesting the eggs.

ADDENDUM

After the manuscript of this paper was sent to the Press, we fed *Ascaris* eggs to two chickens in order to determine if there are conditions in the digestive tract which might prove injurious to these parasite eggs. Examination of the feces twenty hours after feeding showed that most of the embryos of fully developed eggs were free, but dead. Some of the eggs in the early stages of segmentation, when cultured in 2% formalin, failed to develop any further, while some showed the presence of motile embryos after 11 days. These findings are, therefore, in accord with the results described.

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A METHOD OF MULTIPLYING TWO NUMBERS THAT END IN 5.[1]

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METHOD

In the numbers 35, 75, 155, 295, let 3, 7, 15, and 29 be considered respectively as their *tenth* digits.

(1) See if the difference of the two tenth digits is even or odd. If even, the product ends in 25; if odd, the product ends in 75.

(2) Add 1 to the larger tenth digit; multiply this sum by the smaller tenth digit; then add half of the difference of the tenth digits to this product, discarding the half that may result if the difference is odd. The result will be the hundredth digit of the product.

EXAMPLES

1. $35 \times 95 = ?$

$9-3=6$, even number — product .25

$3 \times (9+1) + \frac{6}{2} = 33$ — 33

Therefore $35 \times 95 = 3325$

2. $45 \times 115 = ?$

$11-4=7$, odd number — product 75

$4 \times 12 + 3 = 51$ — 51

Therefore $45 \times 115 = 5175$

With a little practice, two numbers ending in 5 may be readily multiplied mentally.

PROOF OF THE METHOD

Let the larger tenth digit be b; and the smaller one, s. Then the numbers are $(10b+5)$ and $(10s+5)$.

Multiplying we have

$(10b+5)\ (10s+5) = 100bs + 50\ (b+s) + 25 = P.$

But $50(b+s) = 100s + 50(b-s)$

Therefore $P = 100bs + 100s + 50(b-s) + 25,$

$100s(b+1) + 50(b-s) + 25.$

Now if $(b-s)$ is even, $50\ (b-s)$ will be equal to $50 \times 2n$, where n is half of $(b-s)$, an integer. Hence $50\ (b-s) = 100n$ and n to be added to the hundredth digit of the product, which is $s\ (b+1)$. This makes the hundredth digit $= s\ (b+1) + n$ and the last two digits 25.

But if $(b-s)$ is odd then $50\ (b-s)$ will be equal to $50 \times 2m + 50$ or $100m + 50$, where m is $\frac{b-s}{2} - \frac{1}{2}$.
Hence the hundredth digit is $s(b+1) + m$ and the last two digits will be $50 + 25$ or 75.

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[1] Experiment Station Contribution No. 104

In the examples above every step is written. But all of them may be easily performed mentally. Take as an example 65 x 145.

It is easy to see that the last two figures will be 25, and 6 x 15+4=94; the product is 9425.

$$\left.\begin{array}{l} 135 \times 295 = ..\ 25 \\ \quad (13 \times 30+8=698) \end{array}\right\} = 69825;$$

$$\left.\begin{array}{l} 125 \times 495 = .\ 75 \\ \quad (12 \times 50+18=618) \end{array}\right\} = 61875.$$

The above method is of course only practicable when the numbers are small, or when the larger tenth digit is 1 less than a multiple of 10.

COLLEGE AND ALUMNI NOTES

Friends of Prof. Reinking, formerly a member of our faculty, will be pleased to learn that after qualifying for his doctorate in Wisconsin University he accepted a position with the United Fruit Company with far higher salary than he had received here. Dr. Reinking will be stationed at Tela, Honduras, and engaged almost exclusively in diseases of bananas. This means that we have lost another of our most effective men through inability to meet the rates of salary being paid in other parts of the world.

On November 9, 1922, the president of the Senior Class of the College of Agriculture received a telegram informing him of the arrival at Manila of Durian seedlings from Davao, Mindanao. The Class has adopted this particular plant as the tree to be planted during their Class Day celebration.

The Visayan Club held its inaugural dance at the Forest School on Saturday Nov. 4. The reception Committee consisted of Professors Roa, Pfluger, and Salvosa. Mr. Henaris and Dr. Manresa, and about a hundred were present.

Venerando Marilao, '22, is now working with the Maao Sugar Central Co. at Pulupandan, Negros Occidental, under the direction of the Bureau of Science.

On Nov. 3 the members of the Senior Class of the College of Agriculture went on a two days' excursion to the island of Talim, Rizal. Despite the bad weather the excursionists enjoyed their visit to the three barrios. They sailed back to Los Baños at noon on November 5, after spending 36 hours in the Island. Thanks are extended by the Class to Mr. Primo San José, a Talimian senior, who acted as leader, and to the people of Tana, Lambac, and Balibago for their hospitality and their courteous appreciation of the visit.

Ramon K. Habaluyas, '19, is engaged in farming in Nueva Ecija. He was here for a few days' visit during the last week of October.

Tomas D. Harder, '19, is in charge of LaPaz Demonstration Station of the Bureau of Agriculture at La Paz, Iloilo.

Antonio C. Sanchez, '22, is at present operating his own farm at Clarin, Bohol.

Francisco D. Marquez, formerly in charge of the La Carlota Experiment Station, has gone into farming. In a letter recently received he says he is planting coffee trees, has planted avocados and limas and intends to plant bananas

and coconuts soon. He has a few head of cattle including an Indian bull. He has applied for the commutation of his accrued leave and expects to use the proceeds for the extension of his farm located at Biao, Binalbagan, Occidental Negros.

Cenon R. Paulican, '17, is now managing Dagumban Cattle Ranch. His present address is Dagumban, Bukidnon.

Leopoldo G. Mendoza, '17, is in charge of a rice farm of over 300 hectares, owned by Mr. E. E. Schneider, his step father, in Mabatobato, Pili, Camarines Sur. Mr. Mendoza is using a Witchita tractor as an experiment in the introduction of modern machinery in rice fields. It may be of interest to the other alumni to read the following advice of Mr. Mendoza with regard to the use of these farm implements:

> "Consider the matter thoroughly before introducing farm machinery into your farm and be sure then that you have plenty of cash on hand when you buy the machine, especially if it is to be used in rice fields."

Claro Samonte, '18, is at present a Provincial Agricultural Inspector of the Bureau of Agriculture stationed in Bayonbong, Nueva Viscaya. He writes that the province of Nueva Viscaya offers a good place for the graduates of the College if they want to go directly into farming. Mr Samonte is married and is now the father of two husky "junior farmers".

In the recent Junior-Senior dual meet held last November, 1922, in the College of Agriculture, the Seniors proved superior to their opponents. They won the indoor baseball, volley ball and baseball and tied in the basket ball. The football is to be decided at some future time.

ACKNOWLEDGMENT

In his article "Concerning the Sugar Cane Root Parasite, Aeginetia indica," (Philippine Agriculturist **11,** 3, 89-90) Professor McWhorter accidentally omitted to acknowledge the source of the photographs from which the accompanying plates were made. They were taken by the Bureau of Science, Manila.

A man is like a tack: he can go only as far as his head will let him.

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PRUSSIC ACID IN PHASEOLUS LUNATUS AND OTHER BEANS[1]

By Ciriaco B Serrano

The hydrocyanic acid[2] content of the different varieties of *Phaseolus lunatus*, Linn. and other plants have been determined by chemists in Germany (1), France (2), Cuba (3), United States (4), British India (5), and Trinidad Tabago (6), but here in the Philippines investigation with reference to this subject, if any has been made, has not been published. Hydrocyanic acid, either free or as a cyanide, is deadly poisonous to men and to animals. Cases of poisoning of cattle by the leaves and pods of the wild varieties of *Phaseolus lunatus*, Linn., *sibatse simaron* (Tagalog), have been reported to the writer by farmers from Batangas and elsewhere.

A local daily newspaper[3] reported from official sources the death of two persons on January, 1922, as the result of eating *bule patani*. Five other persons who ate of the same beans were seriously ill. The beans eaten were gathered in the woods. These men were laborers employed by the Mabalacat Sugar Mills Company, Pampanga. All efforts by physicians to save the lives of the two men were in vain.

The *bule patani*, according to some students in this College from Pampanga, is the wild black variety of *Phaseolus lunatus*.

SURVEY OF LITERATURE

Simpson (3) reports that, of the many varieties examined by him, only Rangoon blanca was found to contain more than 40 milligrams of hydrocyanic acid per 100 grams of sample.

Grimme (2) reports that the colored cultivated varieties of Rangoon beans, *Phaseolus lunatus*, contain as high as 0.24 per cent hydrocyanic acid, while the white variety of commerce contains only from 6 to 12 per cent of the limiting value of 0.02 to 0.035 per cent hydrocyanic acid set by the French and German governments.

Dunbar (7) in a discussion of the HCN content of Rangoon and moon beans and the advisability of their use as food, advises excluding them from diet of children under ten years, because cooking with decantation of the liquor may remove only one half of their prussic acid (HCN) content.

[1] Thesis presented for graduation from the College of Agriculture, No 145; Experiment Station contribution, No. 105.

[2] Hydrocyanic acid is more commonly known as prussic acid The two terms are used interchangeably in this paper.

[3] *The Philippines Herald* of February 10, 1922.

a. The toxic action of Rangoon beans.—Gabel and Krüger (8) report that Rangoon beans contain from 48 to 357 milligrams HCN per kilogram, and boiling for 2 hours leaves about 24.5 per cent of the total HCN content. Beans boiled for 2½ hours, containing originally 354 milligrams per kilogram, were eaten by two persons for supper. The amount eaten was equivalent to 100 grams raw beans. One vomited at noon the next day. The urine of both persons contained about 2 milligrams HCN. Boiled beans containing, originally, 175 milligrams HCN were eaten by two persons for supper. The amount taken was equivalent to 250 grams raw beans. At noon, the same amount was eaten. There were no external symptoms of ill effect, but the urine contained traces of HCN. According to Amberg (8) France permits the sale of beans with less than 200 milligrams prussic acid (HCN) per kilogram of sample.

b. Physiological action of prussic acid on the huma system (9).—

> Prussic acid first stimulates and then paralyzes the central nervous system in mammals. It acts on so many forms of living matter that it merits the designation of a general protoplasm poison. The fatal dose to man is believed to be about 0.05—0.08 g. (1-1½ gr.) of the pure acid. Prussic acid has gained its reputation of being the most dangerous of poisons.
>
> After very large doses in mammals, there may be practically no symptoms; the animal falls to the ground with a slight convulsive movement or a scream, and death follows in a few seconds from simultaneous arrest of the heart and respiration.
>
> In small quantities, prussic acid has a bitter, burning taste, which is accompanied by salivation, and is followed by a numbness in the mouth and throat. A sensation of warmth in the stomach is followed by nausea and vomiting, confusion and headache, dyspnaea, slow pulse and general muscular weakness. The pupils are widely dilated and the eyeballs protrude. Unconsciousness follows, and then violent convulsions. Respiration becomes extremely slow and eventually ceases, while the heart continues to beat for some time afterwards. * * *
>
> Besides its specific action on the central nervous system, prussic acid exercises a depressant action on protoplasm in general, and may therefore be called a general protoplasm poison, although some of the bacteria are but little affected by it. Both plants and animals are retarded in their movements and in their nutritive processes by its presence, although they may recover and show no subsequent deterioration provided the poison acts only during a short time and in sufficient dilution. * * *

This paper presents the relative amount of prussic acid (HCN) found by the writer in wild, semi-cultivated, and cultivated *Phaseolus lunatus* found in the Philippines; the effect of different treatments on the removal of the poisonous acid from them; and the effect of the boiled beans on guinea pigs.

This work was conducted at the College of Agriculture, University of the Philippines, during the College year 1921-1922.

MATERIALS

1. VARIETIES ANALYSED

The following beans were tested for the presence of HCN; the wild, semi-cultivated, and cultivated *Phaseolus lunatus* Linn., mungo (Tagalog), *Phaseolus*

radiatus Linn., calamismis (Tagalog) and calamismis (Ilocano), *Psophocarpus tetragonolobus* Linn., and cowpeas, paayap (Tagalog), *Vigna sinensis* Savi.

For the purpose of the present studies, *Phaseolus lunatus* is the most important of these beans, for the others are not popularly rated as poisonous.

Phaseolus lunatus is described by Merrill (10) as follows:

> *Phaseolus lunatus*, Patani (Tagalog), is a scandant, slender, annual, glabrous or sparingly pubescent, herbaceous vine reaching a length of 4 meters or more, the stipules small, basifixed. Leaflets ovate, acuminate, thin, 6 to 12 cm. long. Racemes axillary, solitary, peduncled, 8 to 10 cm. long. Flowers long-pedicelled, about 13 mm. long, the calyx pale-greenish or pale yellowish. Pods oblong, somewhat curved, 6 to 12 cm. long, about 2 cm. wide, containing from 1 to 4 large, variously colored or white seeds.
>
> Frequently cultivated for its edible beans, flowering September to April. Cultivated in all tropical and warm countries, a native of tropical America.

Table I gives description of the varieties of *Phaseolus lunatus* analyzed for HCN by the writer. The College wild purplish brown (F_5) and the wild black (F_3) were from a wild stock but had been under cultivation in the College Experiment Station for five and three years, respectively. The wild beans, *sibatseng gubat*, from Lipa and Talisay were gathered in the woods. The semi-cultivated *sibatse* from Taal was gathered in the sugar cane fields and on an uncultivated farm. They were growing wild. All of the beans named in Table I, with the exception of the ones obtained from San Antonio, Los Baños, and the green pods from Lipa, were ripe and had been partially dried in the sun.

TABLE I.—*Varieties of Phaseolus lunatus studied*

No.	Variety name	Color of beans.	Source	Remarks
1	College wild purplish brown (F_5).	Purplish brown	Col. of Agriculture	From wild stock
2	College wild black (F_3) .	Black	Col. of Agriculture	From wild stock
3	Sibatseng gubat, or simaron.	Pale brown	Lipa, Batangas	Wild
4	Sibatseng gubat, or simaron.	Black	Talisay, Batangas	Wild
5	Sibatseng gubat, or simaron.	White	Talisay, Batangas	Wild
6	Sibatseng gubat, or simaron .	Purplish brown	Talisay, Batangas	Wild
7	Sibatseng gubat, or simaron.	Light purple	Talisay, Batangas	Wild
8	Sibatse	Black	Taal, Batangas	Semi-cultivated
9	Sibatse	White	Taal, Batangas	Semi-cultivated
10	Patani	Purplish gray	Taal, Batangas	Cultivated
11	Patani . . .	Purplish gray	Los Baños, Laguna	Cultivated

METHODS OF ANALYSIS

1. PREPARATION OF SAMPLE

Each sample was ground in a meat grinder, powdered in an iron mortar, and then passed through a one-half millimeter mesh sieve to make the sample uniform.

2. QUALITATIVE ANALYSIS

a. Extraction and identification.—The methods employed in the analysis are, in general, those described by Warren (11), and by Guignard (12). The Guignard's simple picric reagent was prepared by dissolving one gram of picric acid in 100 cc. of distilled water and adding to the solution 10 grams of crystal-

lized potassium carbonate. The test was performed by hydrolyzing a 50-gram sample in a suitable flask with 50 cc. N/10 sulfuric acid and 400 cc. water. A filter paper dipped in the picric acid solution prepared as described above was suspended in the neck of the flask. The flask was corked tight and allowed to stand at room temperature for 24 hours. The production of an orange-red color on the picric acid paper indicated the presence of prussic acid or a cyanogenetic glucoside (HCN). This identification was confirmed by hydrolyzing a sample and extracting the prussic acid by steam distillation. The acid volatilizes readily with steam. The first 5 or 20 cc. of the distillate were tested for the presence of hydrocyanic acid by the following methods as described by Warren (11): 1, *the prussian blue test*, 2, *the sulphocyanate test*, 3, *the Vortman's nitroprusside test*, 4, *the silver nitrate test* and 5, *the picric acid test*.

3. QUANTITATIVE ANALYSIS

a. Extraction and determination.—Twenty-five grams of newly powdered sample in a two-liter distilling flask were treated with 100 cc. distilled water, and the mixture acidified with 50 cc. of N/10 sulfuric acid. The distilling flask was then connected to a condenser, the extreme end of which was attached to a one-liter receiver by a glass tube in such a way that the end of the glass tube was below the surface of the potassium hydroxide solution contained in the receiver. This arrangement was found necessary to prevent any possible loss of hydrogen cyanide gas during distillation; otherwise the loss during hydrolysis and distillation was quite appreciable as may be seen in the preliminary tests. The samples were hydrolyzed at room temperature from 18 to 24 hours and after hydrolysis the HCN was distilled with steam until about 500 cc. of distillate was collected. The receiver was immersed in a tin casserole containing ice and water to maintain the temperature of the distillate at 15°C., for hydrogen cyanide volatilizes at 25°C. The alkaline distillate was then titrated with the standard silver nitrate solution using Liebig's method (13).

EXPERIMENTAL RESULTS AND DISCUSSION

1. QUALITATIVE ANALYSIS

Table II gives the results of the qualitative determinations of the different varieties of *Phaseolus lunatus*,—the wild, the semi-cultivated, and the cultivated, and those of mungo, calamismis, and cowpea. All the varieties of *Phaseolus lunatus* gave positive results as indicated by the plus sign (+), while the other beans gave negative results, as indicated by the minus sign (−).

2. QUANTITATIVE DETERMINATION

a. Preliminary tests.—Preliminary tests were run because in running the qualitative tests it was observed that when the delivery tube of the distilling flask was connected to the silver nitrate ($AgNO_3$) solution during hydrolysis and distillation, some of the hydrogen cyanide came over and formed a grayish curdy precipitate of silver cyanide before any condensible distillate passed over. Table III gives the comparative results under different conditions. When the end of the delivery tube was immersed in the alkali solution during hydrolysis and distillation, the average amount of prussic acid per 25-gram sample hydrolysed for 18 and 24 hours was about the same, but when the distillate was just allowed to drop into the alkali solution there was a loss of 5.43 milligrams of prussic acid per 25 grams, as compared with the average of the two averages in the former determinations.

TABLE II.—*Qualitative analysis of beans.*

Names of beans.	Guignard's simple picric acid test paper.	Prussian blue test.	Sulphocyanate test.	Vortman's nitroprusside test.	Silver nitrate test.	Picric acid test.
1. College wild purplish brown sibatse (F_5)	+	+	+	+	+	+
2. College wild black sibatse (F_4)	+	+	+	+	+	+
3. Lipa pale brown sibatseng gubat	+	+	+	+	+	+
4. Talisay black sibatseng gubat	+	+	+	+	+	+
5. Talisay white sibatseng gubat	+	+	+	+	+	+
6. Talisay purplish brown sibatseng gubat	+	+	+	+	+	+
7. Talisay light purple sibatseng gubat	+	+	+	+	+	+
8. Taal semi-cultivated black	+	+	+	+	+	+
9. Taal semi-cultivated white sibatse	+	+	+	+	+	+
10. Taal purplish gray cultivated patani	+	+	+	+	+	+
11. Los Baños purplish gray cultivated patani	+	+	+	+	+	+
12. Mungo	—	—	—	—	—	—
13. Ilocano calamismis	—	—	—	—	—	—
14 Tagalog calamismis	—	—	—	—	—	—
15 Cowpea (the white, the spotted and pale brown varieties)	—	—	—	—	—	—

TABLE III. *Comparison of results obtained under different conditions, using College purplish brown beans* (F_5)

(Figures are in milligrams per 25-gram sample)

Number of determinations	With end of delivery tube immersed in the alkali solution		Allowing the distillate to just drop into the alkali solution
	Hydrolysed 18 hours	Hydrolysed 24 hours	Hydrolysed 24 hours.
	milligrams.	*milligrams.*	*milligrams.*
1	13.35	15.19	9.50
2	15.19	15.32	10.00
3	15.07	15.19	9.68
4	15.19	15.07	10.06
5	15.45	15.26	9.68
6	15.13	15.13	9.81
7	15.07	15.38	9.56
8	15.19	15.19	9.94
Average	15.21	15.22	9.78

Incidentally, it was found that loss of prussic acid also occurred when a powdered sample was exposed to room temperature for some time. Drying the whole beans in the sun and at the temperature of boiling water under vacuum, removed part of the hydrocyanic acid from the beans. These results are shown in Table IV. In this table, No. I shows that the loss of HCN after exposing the powdered beans to room temperature for 3 weeks was 19.46 per cent of the original HCN content; the loss after drying the whole beans (No. 2) in the sun for 4 days was 5.65 per cent, while in No. 3 it was 13.78 per cent, and in No. 4 the loss was 77.80 per cent. A commercial possibility for the removal of HCN from these beans is indicated by the latter results.

b. The quantitative determinations.—Table V shows the results of the quantitative analysis of the beans as described on pages 168 and 169.

TABLE IV.—*Loss of HCN when beans were subjected to different treatments.*

No.	Treatment	Variety used.	Moisture lost	HCN content per 25 grams before treatment		HCN content per 25 grams after treatment		HCN in per cent of treated beans.		Loss in per cent of total HCN of fresh sample.
						Fresh sample.	Dried sample	Fresh sample.	Dried sample.	
			per cent	*mg*	*per cent*	*mg*	*mg*	*per cent*	*per cent*	
1	Powdered sample exposed to room temperature for three weeks	College wild purplish brown	6.69	15.21	0.0608	12.25	13.13	0.0490	0.0525	19.46
2	Whole beans dried in the sun for four days.	College wild purplish brown	0.44	15.21	0.0608	14.35	14.59	0.0574	0.0584	5.65
3	Whole beans dried in the sun for four days	Lipa wild pale brown	4.76	61.36	0.2454	52.92	55.57	0.2117	0.2222	13.78
4	Whole beans dried at 100° C. for one hour under vacuum.	Lipa wild pale brown	4.01	61.36	0.2454	13.70	14.27	0.5480	0.0571	77.80

TABLE V.—*Prussic acid content of some Philippine beans (Phaseolus lunatus).*

No.	Variety name	Conditions of sample	HCN per 25-gram sample.		Remarks [a]
			mg.	*per cent.*	
1	College wild purplish brown sibatse (F_3)	Ripe beans	15.22	0.0608	Av. of 8 determinations. Variation: +.0003%.
2	College wild black sibatse (F_3).	Ripe beans	23.52	0.0940	Av. of 8 determinations. Variation: +.0003%.
3	Lipa pale brown sibatseng gubat	Ripe beans	61.36	0.2454	Av. of 8 determinations. Variation: +.0001%.
3-a	Lipa pale brown sibatseng gubat	Beans from green pods	14.38	0.0575	Av. of 8 determinations Variation: —.0004%.
4	Talisay black sibatseng gubat	Ripe beans	20.71	0.0828	Av. of 8 determinations. Variation: —.0003%.
5	Talisay white sibatseng gubat	Ripe beans	20.64	0.0825	Av. of 8 determinations. Variation: —.0002%.
6	Talisay purplish brown sibatseng gubat	Ripe beans	79.69	0.0787	Av. of 8 determinations. Variation: —.0001%.
7	Talisay light purple sibatseng gubat	Ripe beans	15.38	0.0615	Av. of 8 determinations. Variation: —.0001%.
8	Taal black semi-cultivated sibatse	Ripe beans	13.80	0.0552	Av. of 8 determinations. Variation: —.0001%.
9	Taal white semi-cultivated sibatse	Ripe beans	12.26	0.0490	Av. of 8 determinations. Variation: +.0002%.
10	Taal purplish gray cultivated patani	Ripe beans	7.42	0.0296	Av. of 8 determinations. Variation: +.0002%.
11	Los Baños purplish gray cultivated patani	Ripe beans	2.83	0.0112	Av. of 3 determinations. Variation: +.0001%.

[a] The variations in each eight determinations were not great. They were likely due to titration.

According to Table V, No. 3, the ripe beans from *sibatseng gubat*, the pale brown *Phaseolus lunatus*, contain 2,454 milligrams prussic acid per kilogram, or about twelve times as much as beans permitted to be sold by the French Government. According to this table, all of the varieties with the exception of No. 11, the Los Baños purplish gray cultivated patani, would be excluded from the market were the French regulations followed here.

The fatal dose of HCN to man according to Cushny is about 50 milligrams. On the supposition that the HCN in the beans would be easily liberated in the human stomach, the following will be the amount of these beans necessary to produce fatal results if eaten by man.

TABLE VI.—*Amount of each bean necessary to give the fatal dose of HCN to man.*

No.	Bean	Fresh Beans.	Cooked beans drained from the water used in boiling. Assuming 20% of HCN is left in the beans.		Remarks.
		grams.	*grams*	*Table-spoonfuls*	
1	College F,	82	110	25	The per cent of HCN left in the beans after cooking will depend on the variety and condition of the beans.
2	College F_3	53	265	15	
3	Lipa pale brown	20	100	6	
3-a	Lipa pale brown (green beans)	87	435	26	
4	Talisay black	60	300	18	
5	Talisay white	60	300	18	
6	Talisay purplish brown	64	320	19	
7	Talisay light purple	81	405	24	
8	Taal black	91	455	27	
9	Taal white	102	510	31	
10	Taal purplish gray	169	846	51	
11	Los Baños purplish gray	447	2235	134	

There is a general belief among people that the poisonous substance, the HCN, of wild varieties of *Phaseolus lunatus* can be lessened by cultivation. Table V shows that the College wild black (F_3), which had been under cultivation for three years and the same variety, wild, from Talisay contain about the same amount of HCN. The cultivated beans contained a slightly greater amount. The variation would undoubtedly be due to the different soils and climatic conditions of the two places. Sibley (14) states that the amount of HCN content of beans varies with the soil and climatic conditions. He also states that the formation of HCN in beans is an inherited character of pure single plant culture. The fact that the so-called cultivated beans have very much lower percentage of HCN than the wild ones has not been due to cultivation, but merely to selection, for people would naturally plant for food the harmless rather than the bitter and poisonous varieties.

3. EFFECT OF BOILING WITH WATER AND WITH 50 PER CENT ACETIC ACID ON THE HCN CONTENTS OF POISONOUS BEANS

a. Effect of boiling beans in water.—The writer used in these experiments the Lipa wild pale brown, the College wild black (F_3), and the Talisay wild black beans, which were found to contain the greatest amount of prussic acid. The experiments were run in triplicate. Each sample was boiled for two hours in two 400 cc. portions of water. The liquor was decanted at the end of each hour and analysed both qualitatively and quantitatively for HCN.

TABLE VII.—*Effect of boiling on the prussic acid content of beans.*

Treatment.	Variety used	HCN content per 25 grams originally present.	HCN content per 25 grams after treatment. [a]		Amount of HCN removed in the water decanted off				HCN removed from the beans at the end of second boiling.	
					First		Second.			
			mg	in % of total HCN	mg	in % of total HCN	mg	in % of total HCN	mg.	in % of total HCN
The whole beans were boiled for 2 hours. The water was renewed at the end of the first hour.	1. Lipa wild pale brown	61 36	1 57	2 563	2 23	3 628	1 59	2 433	58 80	99 071
	2. College wild black F_5	23 52	0 95	4 081	1 081	1 260	0 75	3 316	19 44	95.59
	3. Talisay wild black	20 71	0 85	4 130	1 060	4.876	0 68	3 187	16 58	95 80
Green beans were boiled for one hour. The water was not drained out.	4 Los Baños purplish gray (cultivated)	4 33	None	None					4 33	100 00
	Variation		1 2 3	+ .001% + .001% + .001%	1. 2 3	+ .001% + .002% + .001%	1 2 3.	+ .001% + .001% + .002%		

[a] Average of 3 determinations in each variety

The boiled beans were also analysed for HCN after boiling for two hours. This length of time was sufficient to thoroughly cook the Lipa wild pale brown variety but not the two black varieties. The results are given in Table V. Samples of cultivated beans from green pods originally containing 4.33 milligrams HCN per 25 grams were also boiled until they were cooked. This operation took about one hour. The liquor in this case was not decanted off. The whole mass was ground into paste by pressing the beans with the thumb and forefinger. The mixture was then analysed for HCN in the usual way. The results are given in Table VII.

This table shows that of their original contents of HCN, the Lipa wild pale brown *Phaseolus lunatus* which originally contained 0.245 per cent of HCN, lost, after boiling for two hours, 99.07 per cent; the Colleg wild black (F_3), which originally contained 0.094 per cent of HCN, lost 95.59 per cent; and the Talisay wild black, which originally contained 0.083 per cent of HCN, lost 95.80 per cent. The green beans were freed completely from HCN by boiling one hour.

b. Effect of boiling the beans with acetic acid.—Since HCN is a much weaker acid than acetic acid, it was thought that boiling the beans with vinegar in the water would completely remove the prussic acid. The same varieties used in Table VI were employed in these experiments. The beans were boiled with 50 cc., 50 per cent acetic acid and after decanting the liquid the beans were analyzed for HCN. Qualitative tests gave negative results, showing the complete removal of HCN.

4. THE EFFECT OF FEEDING THE BOILED BEANS TO GUINEA PIGS

The boiled beans obtained in experiments described above were given to guinea pigs. The amount given to each was equivalent to 34.9 grams of the raw beans. The Lipa wild pale brown, and the College wild black (F_3), the varieties containing the largest percentage of HCN were used, both after boiling in plain water and with 50 per cent acetic acid. Table VIII shows the results of the feeding experiments.

The acidity of the beans boiled with acetic acid was partly removed by treating them with lime water and washing thoroughly with water. In the case of the beans boiled with water, the animals ate only small amounts, perhaps because of its bitter taste; of the beans boiled with acetic acid, the animals ate almost all of their portions, even though they were slightly sour. The animals fed with beans boiled in water alone became sluggish in fifteen hours and remained in that condition for four hours, while animals 3 and 4, fed on beans treated with acetic acid, showed no apparent ill effect. After 24 hours, the feed for the first two animals was renewed but they still refused to eat, though they were apparently very hungry. The feeds of the animals were then exchanged so that pigs 1 and 2 received the acid-treated beans and pigs 3 and 4 the water-boiled ones. The first two animals now ate their ration and the other two refused to eat. For lack of time the experiment was discontinued. The results show that guinea pigs easily detected the presence of even as low as 0.0063 per cent of HCN in the boiled beans, the amount of HCN found in the Lipa wild pale brown variety after boiling with water for two hours.

TABLE VIII.—*Feeding trials with guinea pigs using the boiled beans.*

Animal number.	Variety used.	Treatment	HCN content per 25 gm. sample after boiling	Amount eaten	Remarks.
			mg		
1	Lipa wild pale brown	Boiled in plain water for two hours	1.57	Very little	Animals became sluggish 15 hours after the experiment was started and remained so for four hours
2	College wild black (F_3)		0.95	Very little	Effect similar to No. 1 although not so pronounced.
3	Lipa wild pale brown	Boiled in 50 per cent acetic acid for two hours	1.57	Practically the whole ration was consumed.	No apparent ill effect.
4	College wild black (F_3)		0.95	Practically the whole ration was consumed	No apparent ill effect.

CONCLUSIONS

1. The hydrocyanic acid contents of a number of varieties, both cultivated and wild, of *Phaseolus lunatus* have been determined with the following results:

	Per cent HCN
Wild variety	0.060–0.240
Semi-wild variety	0.049–0.055
Cultivated variety	0.030
Green beans, wild variety	0.030
Green beans, cultivated	0.011

2. *Phaseolus mungo*, calamismis (*Psophocarpus tetragonolobus*) and cowpea (*Vigna sinensis*) do not contain hydrocyanic acid.

3. There is a gradual loss of HCN in powdered beans exposed to room temperature and in whole beans exposed to sunshine. Heating whole beans under vacuum for one hour at 100°C. removes 76.74 per cent of the HCN content. The latter method may be developed into a commercial way of removing HCN from the beans before placing them on the market.

4. About 95 per cent of the HCN content of beans is removed by boiling then with water for two hours. Even after this treatment, the beans contain enough of the poison to give it a bitter taste. Boiling with acetic acid for two hours drives out the hydrocyanic acid completely.

5. Beans boiled with acetic acid for two hours and then treated with lime water to remove the sour taste are relished by guinea pigs and produce no ill effect on them. Beans boiled in a plain water for two hours are not relished by these animals, even when the latter are hungry to the point of starvation.

RECOMMENDATIONS

The wild varieties of *Phaseolus lunatus*, as well as the cultivated ones, containing HCN, may be safely used as human food provided they are boiled thoroughly in vinegar 50 per cent strong and the liquid thrown away. To remove the sour taste, the boiled beans may be treated with lime water, and then washed thoroughly with boiled water When not treated in this way, the beans are not safe articles of food, since small amounts of HCN would be left, and this may cause a bad effect, to greater or less degree on the health.

ACKNOWLEDGMENT

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THE GAS IN THE COCONUT[1]

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The physical and chemical changes taking place in the developing coconut have been studied by a large number of workers (1) (2) (3) (4) (5), but the fact that they have attacked the subject from an agronomical or from a chemical point of view means that our knowledge of its physiology is still far from complete. In the following paper is presented some data on the origin and nature of the gas found in the nuts.

The process of fertilization of the coconut has been dealt with by Hunger (5). The changes in the ovule after fertilization follow the lines of development typical of Angiosperms. The process is described in textbooks on the subject (6). One of the generative nuclei of the pollen tube unites with the egg nucleus in the embryo sac while the other passes on and fuses with the endosperm nucleus. The egg nucleus develops a cellulose wall and by repeated division gives rise to the embryo, while the endosperm nucleus divides, forming a large number of nuclei in the protoplasm of the embryo-sac. Later these nuclei form cell walls round themselves and these cells compose the tissue of the endosperm.

The protoplasm lines the walls of the embryo-sac, and encloses a vacuole. The milk of the developed coconut represents this vacuole, and the endosperm or "meat" forms a parietal layer corresponding to its origin from the endosperm nuclei. In section the cells of the endosperm are found to be tubular and radial and, when mature, are three to four times as long as wide. When first formed they are approximately spherical. Their further growth is hampered laterally by their neighbors, and consequently they become elongated in the direction of the diameter of the fruit. The development of the endosperm cells continues for about ten months. After this time there is very little increase in number, though considerable chemical change takes place.

The development of the endosperm of course begins at fertilization, but the formation of cell walls is at first slow. For the first few months the amount formed is small and is represented by a gelatinous layer at the end remote from the embryo. When the nut is six months old the amount of endosperm becomes appreciable to the casual observer. "The meat has begun to form." By repeated division of the nuclei, followed by cell formation, the endosperm is produced as a continuous layer round the cavity.

The cavity is filled with liquid until the endosperm has attained considerable thickness and is apparently solid enough to preclude the possibility of the passage of gas through it. The epicarp and endocarp, indeed, together form an effective barrier against the entrance of gas from the outside, the weak point being at the embryo end where passage is possible. An examination of the endosperm and embryo shows that there is the possibility of the passage of air from the outside to the inside. The cylindrical cells of the endosperm have

[1] Experiment Sation contribution, No 106.

relatively large air spaces between them in spite of their apparent close packing when examined with the naked eye.

Any doubt as to the origin of the gas ceases when a number of analyses are made. In the experiments performed a number of nuts of various ages were chosen, and the gas analysed. According to the age of the fruits the composition varied. The amount naturally varies. In young nuts there is none; after the endosperm is well formed, it begins to appear, and when the nut is old about 25 cc. may be found. The first analyses were done on old nuts, and the gas proved to be practically pure nitrogen. This suggested that the nitrogen was residual, and so some young nuts were examined. In nuts containing only 2 or 3 cc. of gas, the composition was found to be very comparable with that of air, the oxygen content being somewhat lower, as is to be expected.

A considerable amount of gas from different young nuts containing 2 to 3 cc of gas was analysed with the following result:

Nitrogen	81.3%
Oxygen	18.7%
Carbon dioxide	trace

In old nuts where the amount of gas averaged 23 cc. per nut, the following was the typical analysis:

Nitrogen	99.8%[2]
Oxygen	.2%
Carbon dioxide	trace

These results show that the gas in the young coconut is air which has entered by way of the one functional germinal pore. (There are three germinal pores, and two are functionless.) As the fruit increase in age more air is admitted, but the oxygen is used in the vital processes of the plant, and the physiologically inactive nitrogen is left.

It now becomes necessary to enquire into the disposal of the oxygen. Is it used in the normal respiration of the cells or is it used in the transformation of the food materials of the endosperm?

The cells of the endosperm contain an extremely large amount of oil, but this is not the case in the younger nuts (2). The percentage of oil increases suddenly during the closing stages of ripening and thus during the germination period decreases and sucrose and invert sugar increase markedly at the same time. The utilization of fats by germinating seeds means the use of tremendous quantities of oxygen. Detmer (7) considered starch to arise from free oleic acid (which is derived from fats) according to the equation

$$C_{18}H_{34}O_2 + 27\ O = 2C_6H_{10}O_5 + 6CO_2 + 7H_2O.$$

This would easily account for the utilization of the small amount of oxygen represented by the volume of nitrogen in a mature fruit of coconut—about 5 cc. at the most. This oxygen is not necessary to the endosperm cells for their normal respiration, as the air is not present till late in the development of the fruit and until that time they have been able to obtain the necessary oxygen from other sources.

The embryo of the coconut is a little different from the type in most oily seeds in that its development is continuous, so that the term germination is rather

[2] No distinction is made here between nitrogen and the other inert gases of the atmosphere (argon, helium, krypton, etc.)

indefinite. What is usually regarded as germination may be retarded or accelerated by varying the water supply, but strictly speaking there is no long period of resting such as takes place between the maturing and germination of a normal seed. The presence of lipase in the embryo and in the milk and endosperm in smaller quantities has been demonstrated by Roxas (4). The continuous splitting of fats by the enzyme and the utilization of the products requires large amounts of oxygen and part of this is provided by the air admitted to the coconut on evaporation of part of the water of the fruit.

It is worthy of note that the slight pressure present in the coconut is not due to the included gas, but to the liquid present in the turgid fruit. This is apparent when a young nut without any gas is examined. The milk will often spurt out when the endosperm is punctured. The same thing may be noticed in other palms, e. g., *Arenga pinnata*, when the turgidity is maintained. If the endosperm and testa be dissected intact out of the outer layers of epicarp and endocarp this turgidity may be decreased by exposure to the air and restored by immersion in water. The fact that the gas is residual would also indicate that it is not responsible for the pressure.

SUMMARY

1. Gas appears in the coconut after the endosperm is well developed.
2. The composition of the gas in the early stages of development is almost that of air, but the oxygen content is rather lower than that of air. As the age of the nut increases the quantity of gas increases, but with progressive decrease in percentage of oxygen.
3. The oxygen is used in the utilization of fat by the embryo, and nitrogen and the inert gases are left forming almost the entire volume of the gas in the old nut.
4. The pressure present in the coconut in due to turgidity, not to the presence of gas.

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A PRELIMINARY STUDY ON THE REPRODUCTION AND FEEDING HABITS OF DERMOGENYS VIVIPARUS PETERS[1]

By FELICIANO R. REVECHE

INTRODUCTION

In the summer of 1921, Mr. D. Villadolid, of the Department of Entomology, College of Agriculture, while making a preliminary study on the feeding habits of the fish fauna of Molawin creek, had occasion to collect a few living specimens of *Dermogenys viviparus* Peters[2] for some biological experimentation. In connection with this study, he found out that this species of fish is a voracious feeder on mosquito larvae.

In June, 1922, Mr. W. D. Tiedeman, of the International Health Board of the Rockefeller Foundation, who is working in cooperation with the Philippine Health Service, arrived at Los Baños and made his headquarters at the College of Agriculture, to study malaria condition in Laguna Province and the possibilities of economic control. He became interested in fish as a possible means of checking the rapid multiplication of mosquitoes. This fish was then mentioned to him by Prof. H. E. Woodworth, of the Department of Entomology, as possible material to work with.

The present is a report on the feeding habits, method of reproduction, local distribution and life history of *Dermogenys viviparus* Peters. This work was begun in the latter part of July, 1922, and ended at the close of November of the same year. The work was done in the College of Agriculture, University of the Philippines.

GENERAL INVESTIGATION

1. DESCRIPTION OF DERMOGENYS VIVIPARUS PETERS

Among the Tagalog people the name "Patlay" and "Kansusuit" are synonymous terms, and these are applied to either of the two fish, *Dermogenys viviparus* Peters or *Zenarchopterus philippinus* Peters. *Dermogenys viviparus* Peters, the subject of this paper, is smaller than the other. For the purpose of uniformity, it would be better to adopt the term "Patlay" to *Zenarchopterus philippinus* Peters and the term "Kansusuit" to *Dermogenys viviparus* Peters, for the simple reason that the people more commonly use "Kansusuit" for *D. viviparus*. The term "Patlay" seems to be commonly applied to a fish having long, slender body and capable of swimming very fast; on the other hand, the term "Kansusuit" seems to be applied to small fish with a body not well adapted to swim rapidly. The former is more characteristic of *Zenarchopterus philippinus* Peters and the latter to *Dermogenys viviparus* Peters.

Peters (1) described this fish as follows: "Tail fin convex; dorsal fin shorter than annal fin; its first ray inserted behind first annal ray; annal fin inserted

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[1] Experiment Station Contribution No. 107

[2] Identified by Dr. A. W. C. T. Herre, of the Bureau of Science. Fowler and Bean, of the Academy of Natural Science of Philadelphia, identified some Philippine specimens which they found labeled *Dermogenys viviparus* Peters as *Hyporhamphus neglectus*. It cannot be determined where these specimens originated. To check this, however, a bottle of specimens was sent by Mr. W. D. Tiedeman, Field Director of the Rockefeller Foundation in the Philippines, under whom this work was undertaken.

after 9/16 of the total length; head semi-flattened; length of head equals 5/16 of the total length; apex of beak yellowish speckled with black, three lines extend from the neck toward dorsal fin, membrane between first and second annal ray, second and third dorsal parts basally spotted behind the operculum with black. Number of scales along longitudinal line 45, transverse 12 to 13, dorsal 10 to 11, annal 14 to 15. Total length 95 mm."

Peters further states, "this species is in its whole body structure very similar to the preceding but considerably larger and one could perhaps consider both as one, but due to the rounded and not two lobed tail fin, as well as to the short dorsal fin, one distinguishes an easily recognizable subgenus of the remaining *Hemirhamphus* for which reason this name *Dermatogenys* (*Dermogenys*) suggested by von Kuhl and van Hasselt was adhered to.

"Dr. Jagor brought this last species from the island of Samar from the river Basey, as is shown in the foregoing specimen 'with living young and developed eggs' ".

Distinct external characteristics of both sexes.-

The female, as a rule, is much larger than the male. The average measurement which is taken from 175 specimens of adult females is 73.5 millimeters in length, and the average measurement of the male, taken from 95 adult specimens, is 52 millimeters in length. The measurement is taken from the tip of the beak to the tip of the tail. All these specimens were caught in the Molawin creek, Los Baños, Laguna.

The caudal fin of the male is beautifully marked with black and pale orange. This marking at the tail is sometimes present in the female, but is not as clear as in the male. The soft rays of the dorsal fin of the male are colored black, and this marking is absent in the female. The ventral fin of the male is also colored pale orange and sometimes little black marks are mixed with it. In the case of the female, the ventral fin is whitish brown, the marks predominating at the soft rays on attaining old age. On the ventral side of the beak of both sexes is a thin fleshy protrusion which runs from the base of the beak to its tip. This protrusion is distinct reddish orange in male, and orange in the female. In the case of the female, there is a protuberance just anterior to the anus which is orange in color. This is absent in the male.

2. THE ALIMENTARY CANAL AND CONTENTS

a. *Method of investigation.*--

The stomach contents of the fish were determined by dissecting the stomach and making water mounts of its contents. Examination was made under a dissecting microscope (×24) or under a binocular microscope (×40).

b. *Digestive system.*-

The alimentary canal of the female fish is a simple tubular organ. It is almost pale white in color, and is situated ventrally to the two sacs of the ovary. It may be resolved into three parts. The most anterior part which is a short, small tube is supposed to be the rudimentary oesophagus, and next to it is a dilated and enlarged portion which may be termed the stomach which covers one-third of the length. The posterior part which makes about two-thirds of the length is termed the intestine. The length of the whole digestive canal is approximately 34 millimeters. The width varies because the most anterior

portion is a small, short tube and next to it is a dilated part which is the stomach and is approximately 4 millimeters in width. The most posterior part which is the intestine is about 2 millimeters in width. On each ventro lateral side of the alimentary canal are two blood vessels running parallel and terminating at the posterior portion, about two-thirds of the length. This description of the alimentary canal is taken from one specimen, 92 millimeters in length and 12.5 millimeters in depth.

c. *Stomach contents.*

Extensive dissection of the alimentary canal of the fish was done with subsequent examination of the stomach contents. Among those things that were conspicuous in the stomach were mostly portions of body parts of insects and arachnids, such as the wings of insects, legs of spiders, heads and legs of ants, legs and abdomens of small locusts, and exuviae of some kinds of immature insects.

3. OBSERVATION OF FEEDING HABITS

Observations of the feeding habits of this fish were made in Molawin creek and in confinement. The fish is provided with a long beak, the lower lip being very much longer than the upper. The fish, therefore, must necessarily be a surface feeder. It could hardly get food at the bottom of the water. If the food happened to be at the edge of a stone or anything that will hinder its progress, the beak is used. Large food is broken into pieces by the mouth before it is swallowed. Oftentimes the young fry are in schools of from twenty to thirty individuals with a few large ones. They are usually found in a slow current of water or near the water edges in the creek or river. They are found abundantly in quiet, shady places of the creek. This is also true with the adult fish, but the latter is often found in more or less rapid currents in which they oftentimes stay and swim. Most of the time they are found on the surface of the water, arranged one after another against the current. They seem to be waiting for their prey to come along with the current of the water. They are very sensitive to noise or disturbances in the water. They react to it positively thinking it possible to be a chance for prey, but are easily frightened at the sight of their enemies. Fighting was observed between individuals in a group over the possessions of a piece of food. If they happened to be of about equal size, they fought hard and strong. They used their beaks as a means of offense and defense.

At night they behave in a very different manner. Most of them are found along the water edges especially in small indentations and stagnant places, swimming around and actively looking for food. They are very active at night, swimming from place to place. This fish is positively phototropic. The writer had occasion to catch a large number of these fish during the night, by attracting them with a lantern into the net.

In pools where this fish was artificially reared, food was given once a day. This food consisted mainly of larvae of both anopheles and culex mosquitoes. Later dried shrimps and white ants or termites were given. The dried shrimps were cut into small pieces before they were given and as such they could be easily swallowed by the fish. Of all this food, the writer found that the fish prefered the anopheline larvae. This might possibly have been due to the fact

that the anopheline larva places itself parallel to the surface of the water. It could be, therefore, readily seen by the fish which feeds on things floating on the water. It may be that in nature it prefers water insects as examination of the stomach contents would seem to indicate.

The following table shows how readily anopheles larvae are eaten by this fish when in confinement. It remains to be seen how this would be modified under natural conditions.

TABLE I.—*Showing the efficiency of Dermogenys viviparus Peters in eating mosquito larvae in an artificial container.*

Date	Fish number.	Number of anopheline larvae given.	Number of larvae eaten after					Total 5 hrs. & 38 min
			8 min.	30 min.	1 hr.	2 hrs.	3 hrs.	
11-27-22	A_1	82	36	+ 7	+16	+10	+ 9	78
11-27-22	A_2	59	39	+ 1	+10	+ 3	+ 5	58
11-27-22	A_3	53	9	+ 6	+12	+16	+ 9	52
11-27-22	A_4	54	2	+ 5	+ 9	+15	+10	41
11-27-22	A_5	57	13	+24	+ 3	+ 9	+ 6	55

4. METHOD OF REPRODUCTION

Examination of reproductive organs.—

In the differentiation of the males from the females, the external anatomy was first studied, followed by the dissection for the internal organs. In this connection particular attention was paid to the number of fetuses and developed embryos inside the ovary sacs.

The ovary of this fish is V-shaped in form, and is composed of two sacs. Oftentimes, one of these sacs is shorter than the other. Generally, the color of the ovary is silvery with black markings at the side of each sac. The ovary is located dorsally to the alimentary canal, the latter running straight between the two sacs. It extends from the cloaca to the level of the liver.

The arrangement of the fetuses inside the ovary sacs can be seen from outside, due to the fact that the sac membrane is transparent. The young fetuses in the sacs overlap each other. The position of the fetuses in the sacs is not the same. Oftentimes the heads of the fetuses point toward the cloaca and at other times they point toward the blind portion of the ovary sacs.

The most common number of fetuses is five in each sac. This number increases with the size and age of the fish. In the ovaries there are always found developed embryos and eggs. Measurements of the young fetuses, which supposedly are about to be delivered, were taken. The average length is 18 millimeters.

TABLE II.[1]—*Showing the relative length of the ovary sacs in relation to the total length of the fish with the number of fetuses and embryos found in the ovary sacs.*

Specimen number.	Length of fish.	Ovary sac number	Length of ovary sacs.	Number of fetuses and embryos in the ovary sacs.	
	Millimeter		Millimeter	Fetuses	Embryos
1	63	1	18	4	7
		2	18	5	9
2	120	1	35	10	7
		2	35	11	4
3	50	1	10	—	7
		2	10	2	4
4	85	1	25	4	3
		2	20	5	2
5	63	1	20	3	6
		2	12	7	4
6	60	1	13	5	5
		2	13	4	6
7	65	1	15	—	3
		2	15	—	4
8	98	1	25	5	4
		2	25	5	6
9	60	1	18	3	2
		2	18	5	3
10	64	1	16	5	9
		2	16	4	10
11	100	1	30	11	2
		2	30	5	7
12	75	1	20	4	7
		2	20		6

[1] For lack of space only twelve specimens were noted in this table.

It is shown in the above table that the length of the ovary sacs vary according to the length of the females. Generally, the larger or older females have more young fetuses and embryos in the ovary sacs while the smaller or the younger the females the less the number of fetuses. The fact that the young fetuses are not found in some cases in the ovary sacs of the females may indicate that this fish has a resting period.

5. LIFE HISTORY

Couples of *Dermogenys viviparus* Peters were confined in separate compartments, fed with mosquito larvae or termites, and kept under close observations. As soon as each female produced young, the latter were transferred to Lot B_1, B_2, B_3, B_4, B_5, B_6, B_7, as shown in the succeeding table. Other couples selected from this stock were transferred and confined in another compartment shown as C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, in the same table.

TABLE III. *Showing intervals between parturition and life history of Dermogenys viviparus* Peters *under confinement.*

Couple confined in lot Number.	Date of confinement	Successive dates of parturition	Interval between parturition	Number of young born	Number of lot to which young were transferred First generation	Number of females	Number of males	Number of couples separated from first generation placed in lot No.	Date of paturition Second generation	Number of young born	Number of females	Number of males.	Age at which first generation gave young.
			days										*days*
A1	8 9 22*	8 10 22		4		3	1	C_1	11 3 22	3	2	1	85
		8 11 22		1	B_1	—	1	C_2	11 1 22	2	2	—	83
		8 17 22	6	5	B_2	3	2	C_3	11 6 22	2	2	—	81
								C_4	11 11 22	2	1	1	86
		8 25 22	8	5	B_3	4	1	C_5	11 16 22	3	2	1	83
		9 2 22	8	5	B_4	3	2	C_6					
		9 12 22	10	5	B_5	3	2	C_7					
		10 4 22	22	10	B_6	7	3	C_8					
		10 15 22	11	7	B_7	4	3	C_9					
		* Lost October 19, 1922											
A2	8 10 22*	8 15 22		5	Lot III	3	2						
		8 24 22	9	4	Lot III	2	2						
		9 2 22	8	5	Lot III	3	2						
		* Lost September 29, 1922.											
A3	9 16 22	10 15 22		5	Lot III	4	1						
		11 1 22	17	8	Lot III	6	2						
		11 15 22	14	6	Lot III	4	2						
										Total			.83+ days.

It is worthy of note that a single female gave birth to 5 sets of 5 young each at intervals averaging about 8 days and that these young gave birth to their first group of 2 or 3 young at the average age of only 83+ days

a. *Notes on the stages in the development of the young embryo.*[1]

1. In the first stage of development, the young embryo is enveloped by a thin membrane (Called the chorion, in mammals). The eyes are already developed. The tubular heart is already functioning. On the dorsal part of the embryo running from the most posterior part of the head are black dots which terminate at the anterior part of the dorsal fin. This stage is characterized by the presence of a large amount of yolk.

2. In the second stage, the same characteristic features are found as in the first stage, but differ only in that in the second stage the embryo proper is larger, while the yolk is much diminished in bulk and quantity.

3. The third stage is practically the same as the second stage, but the yolk is distinctly reduced in size and quantity, and the embryo is very much larger. There are black dots appearing very conspicuously in that part of the body mentioned above. The eyes are larger.

4. In the fourth stage, the membrane or chorion which envelopes the embryo seems to bulge out but the young embryo is still coiled in the ovary sacs of the mother. The yolk is greatly diminished in quantity by this time.

5. In the fifth stage, the young fetus appears to be complete in its organs of locomotion. The black dots appearing more prominently. On each side of the young fetus there is a lateral line which begins from the sides of the pectoral fins and terminates at the caudal fin. At this stage of development, small protrusions are visible on the upper beak just anterior to the eyes one on each side.

An experiment was performed to find out whether the young fetuses would live when artificially taken out from the ovary sacs of the mother. The result was that they only lived for two or three days, and in most cases died after three days. Food was given but they would not eat.[1]

b. *Young.* -

The young are born alive. They come out one by one through the cloaca. When outside of the mother's body, they immediately swim to the surface of the water to get air. They look sluggish and inactive, but they can hardly be caught with the hand unaided. The average length of the newly born young is nineteen to twenty millimeters. At this stage, the beak is a little projection at the lower lip. The orange and black markings are absent on both sexes and their distinct color is whitish gray. An attempt made to measure the growth of some of these young failed because they were lost after three days. However, they grew one or one and one-half millimeters in length a day.

c. *Growth.*—

As the young fish grows, its activity increases. The young easily penetrate the pools and water edges seeking food. The female fish attains the mature stage when it is about fifty to sixty millimeters in length, and the male attains maturity at about fifty-five millimeters. At this stage of development, they

[1] NOTES:—It must be noted that beginning from the first stage, the young embryo appears to be transparent to the unaided eyes, but, however, the most discernible organs are the organs of sight and functioning heart

begin to mate. The markings at this stage become distinct on both sexes so that one can easily tell the males from the females.

The female starts giving young at the age of 81 to 85 days. She gives two or three young at the first time. As the female ages, the number of young increases. This generalization is based upon the observation obtained from females reared in confinement. Commonly, an old female will give five young at each parturition, and the maximum number one has been noted to produce is ten. The record of one female (female A_1) shows that from the time she was placed in confinement up to the time she was accidentally killed, a period of 75 days, she was able to produce 42 young. So far this work tends to show that the fish is able to live under artificial conditions and can reproduce a number of young if care is given.

6. HABITAT

a. *Natural.*—

The natural habitat of this fish is the ditch, creek, river or other small stream. In Balanac river near Magdalena, Laguna, this fish was observed and was found to inhabit places of slow current or stagnated places in the river.

b. *Ability to live and reproduce under artificial conditions.*—

Dermogenys viviparus Peters lives and reproduces fairly well in pools which have free circulation of water, and has been found to thrive just as well in stagnant water. The size of the pool where this fish was reared is about four by five meters. It is divided into several lots. In lot 1, enclosed by a wire screen, twenty females and twelve males were introduced in August, 1922, and in November, 1922, the number of the fish in this lot altogether was 332. Most of the females that were introduced in this lot were 73 millimeters long and when they were counted again and examined, some of them had grown to 130 millimeters in length. The males did not exceed 67 millimeters in length. A single female fish under these conditions of confinement produced 15 offspring in the course of three months which, if there were no period of sexual inactivity, would mean 60 for the year. Bearing in mind that the rate of bearing offspring increases with age, this number will be considerably increased.

7. DISEASE

One diseased condition of *Dermogenys viviparus* Peters was encountered in the pools. The attacking organism (a fungus) belongs to the genus ACHLYA[1] which is a free living organism in the water. It grows anteriorly near the eyes of the fish at the beginning and finally affects the eyes. The fish becomes blind and dies afterward. It appears as a white filamentous growth at the head of the fish and is easily recognized. However, it is rarely found attacking this fish.

8 DISTRIBUTION IN LAGUNA PROVINCE

The fish is more or less evenly distributed through the province of Laguna. The fish may be found in the upper courses of most rivers and small streams in the province. The writer found it in abundance in Molawin creek of Los Baños, in ditches in Masiit in Calauan, in ditches in the town of Magdalena, and in ditches and creeks in San Juan, Loñgos. This fish does not seem to frequent the lower courses of the streams. In all the places visited by the writer the fish

[1] Statement from Prof. F. P. McWhorter, of the Department of Plant Pathology, College of Agriculture.

was not observed in places near the mouth of streams. In Molawin creek this fish is very scarce within about a kilometer of its mouth, but is plentiful towards the source. In Laguna de Bay and small lakes of San Pablo such as Bunot, Tikiw, Kalibato, and Sampaloc, the fish is not found.

Association with other fish. -

In the creeks, this fish is seen associated with another very small fish which belongs to the genus Gobio. The latter fish stays mostly at the bottom of the water, and wherever *Dermogenys viviparus* Peters is present the former seems to be present too.

In a pool where this fish was confined, *dalag* (*Ophiocephalus stratus*) was introduced, to find out whether the *Dermogenys* would be eaten by it. Some of the *Dermogenys* were found wounded, but none were eaten.

This fish lives fairly well with top minows (*Gambusia affinis*) in pools. In a one-half barrel filled with water where both were confined in the insectary of the Department of Entomology, they have not attacked each other.

SUMMARY AND CONCLUSION

Dermogenys viviparus Peters is locally found in the province of Laguna in more or less shady places of old streams, ditches, creeks, and rivers. The fish is a highly beneficial fish because of its predacious habits on mosquito larvae. It is a surface feeder and feeds voraciously on anopheline larvae. A small "Kansusuit" (*Dermogenys viviparus* Peters) has eaten 78 anopheline larvae in 5 hours and 38 minutes.

The development of the young embryo may be divided into five stages. The young are born alive. The small fish is generally more active than the large ones.

The female *Dermogenys* matures at the age of 81 to 85 days. She produces two or three young the first time, and as she grows older more young are given out at each parturition. The older female usually gives five young every eight days. This may vary at different seasons of the year and there may be a period or periods of sexual inactivity each year.

The fish lives and reproduces fairly well under artificial conditions. White ants or termites are the best food if it is is reared artificially.

Dermogenys viviparus Peters has some possibilities as a so-called "mosquito-fish". It is a surface feeder by nature and, in confinement, will eat anopheles mosquito larvae readily. It has been known to maintain itself in places where "dalag" and other voracious fish are present. In spite of all this, it has not been demonstrated as yet to be of economic importance in mosquito control although it may be under some peculiar conditions. The fact that the fish is so widely distributed and yet is not found in any one place in sufficient numbers to control breeding, shows that there must be many natural enemies to be overcome. It is true that the removal of grass and weeds from the edges of streams may help by making food more easily available. However, in a section of Molawin creek which is rocky and contains no weeds, we found anopheles breeding in spite of the presence of the fish.

Further work is necessary to demonstrate the practical possibilities of the use of this fish in mosquito control.

ACKNOWLEDGMENT

The author is greatly indebted to Mr. W. D. Tiedeman for his valuable help in the preparation of this paper, also to Dr. A. W. C. T. Herre of the Bureau of Science and Dean C. F. Baker of the College of Agriculture. The illustrations were drawn by Mr. Aniano Estores.

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ILLUSTRATIONS

Plate I

A. Stages in the development of the young embryo.
   1. First stage.. . . . . 3 mm. . . X-8
   2. Second stage. . . . . 3.5 mm.. X-8
   3. Third stage.. . . . . 4 mm. . . . X-8
   4. Fourth stage.. . . . . 4.2 mm. . . X-8
   5. Fifth stage 18 mm. . . . X-3

B. Dorsal view of the head of a newly born *Dermogenys viviparus* Peters. X-15

C. Lateral view of a newly born *Dermogenys viviparus* Peters.. . . X-3

D. Ovary sacs showing the arrangement of the young fish and matured eggs inside.. . . . . X-4

E. Ovary sacs showing the young fish inside, nearly ready to be delivered. X-4

F. Ventral view of the entire alimentary canal and its relation to the ovary sacs of the female *Dermogenys viviparus* Peters . X-2

Plate II.

1. Lateral view of the male.
2 Lateral view of the female.

Plate III.

D. viviparus Peters, showing the arrangement of scales and fins.

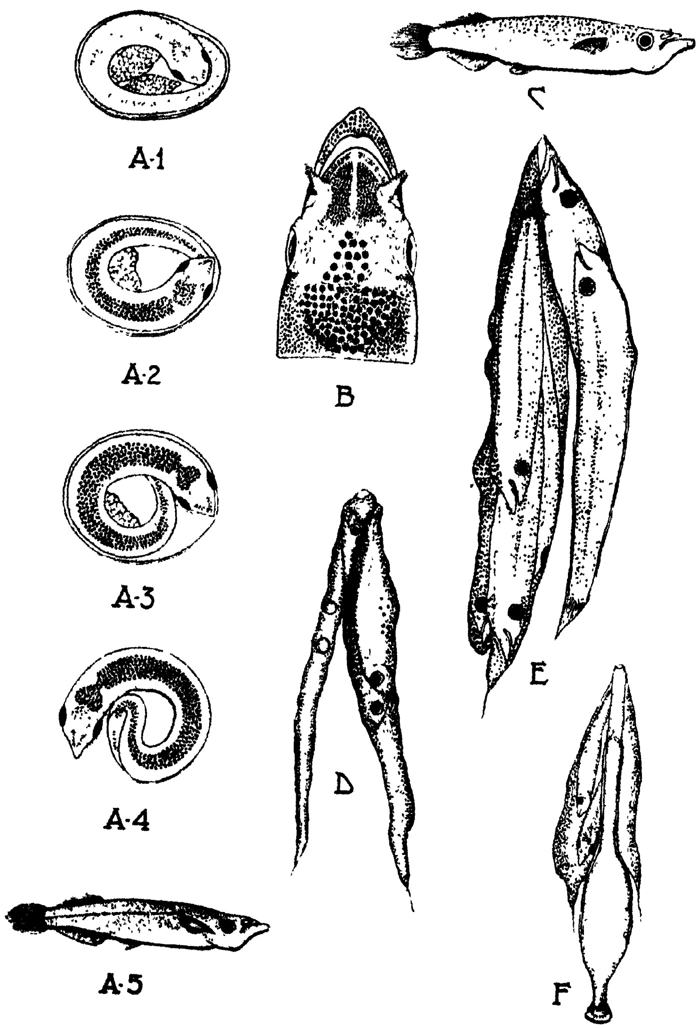

PLATE I

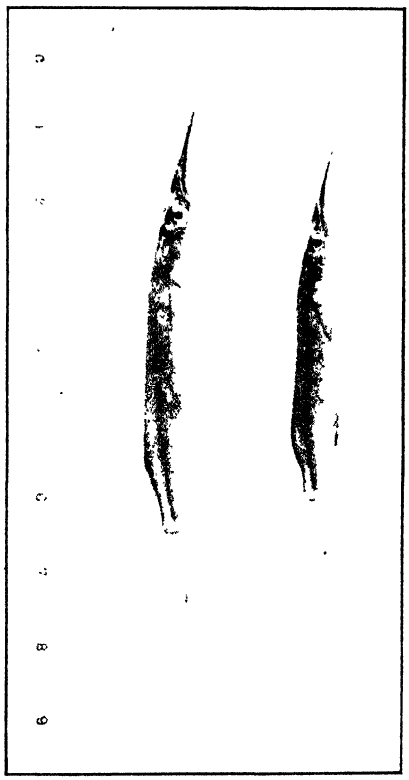

PLATE II

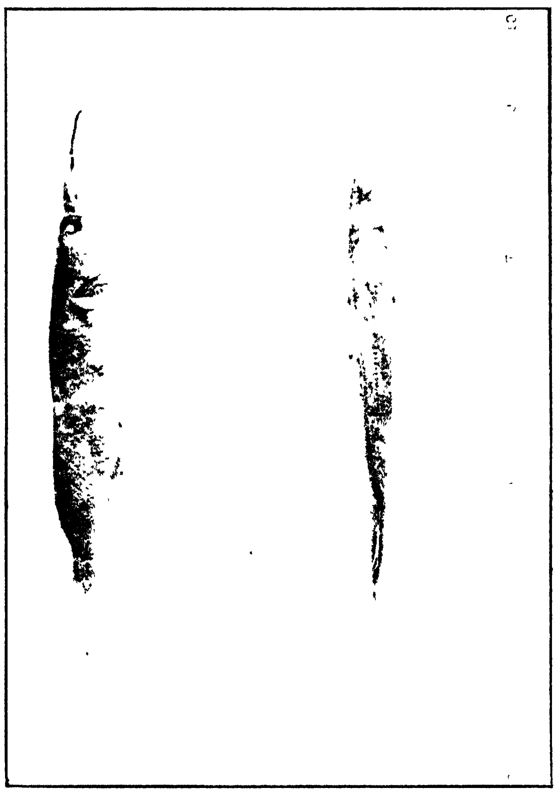

PLATE III

ON THE GERMINATION OF COCONUTS

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Although Copeland (1) and Bacomo (2) have both expressed the belief that coconuts should be used for seed only when fully ripe, yet it appears that no actual comparative tests on this matter have ever been carried out in the Philippines.

In the province of Laguna the writer has talked with several coconut planters and has seen their seed beds of coconuts in the back of their yards and has found that they use nuts the husk of which is still green, and in which the milk can be shaken. These planters argue that such nuts are better material for germination than the dry-husk nuts. They claim that they are fast growers.

In addition to the stage of ripeness of the nuts there is another point that should be considered in connection with germination of the coconuts in a seed bed, which is the right position of the nut.

Copeland in his book "The Coconut" (1) states that the seeds should be placed on the side. It may be that Copeland was using results of experiments in other countries (5), (4), (5). It appears that Philippine literature based on actual comparative tests on this subject is wanting. It was, therefore, the main object of this little class experiment (carried out at this College by a few students who took up the course on Oil Plants in the summer of 1920) (*a*) to determine experimentally whether the "green-husk" or "dry-husk" nut is better material for germination, consequently for seed; and (*b*) to determine the best position of the nut and what treatment to give it to obtain excellent germination in the seed bed. It might be said also that another object of this test was to determine the influence of watering upon the rate and percentage of germination. This study was carried out during the months when rainfall was supposed to come seldom, but the opposite was the condition in this year. The results, therefore, on germination of the nuts as influenced by artificial watering not being reliable because of the rainfall, they will not be discussed in this paper.

Summarizing the objects of the brief but careful study here reported on the germination of the coconut in the seed bed, we have—

1. To determine whether the nuts with dry husks (dead ripe) or those with green husks (the water in the shell shakes) are suitable seed nuts.

2. Which position, (top up, side down or top down) of the nuts is best in germination.

3. What treatment should be given the nut that would be favorable to rapid germination.

I. METHODS OF GERMINATION IN GENERAL

It will not be amiss to give a brief description of the different methods in vogue in the germination of coconuts, before presenting the results obtained from the study presented in this paper.

[1] Experiment Station Contribution No 108

The methods practiced in the Philippines and elsewhere may be classified as belonging to two or three main categories. The first we may term the Hanging Method; the second, the Seed Bed Method; and the third, the Direct to Field Method.

One way of germinating seeds of coconut by the Hanging Method is to tie the nuts in pairs by strips of their husks and to hang them over poles held in horizontal position by posts. Another way is to tie the nuts around a vertical pole, one above the other, forming a sort of cylinder with the pole at the center. The Hanging Method is employed quite commonly by the planters around the foot of Mount Banahao where the humidity of the air is high. This method should never be used when any one or more of the following conditions exist:

1. When the moisture content of the air is low d ring the period of germination.

2. When labor or water is not available to water the seeds when rain fails to supply the necessary moisture for the germinating nuts.

3. When the prospective plantation is ready or will soon be ready for planting.

The advantages of using the Hanging Method are:

1. It is economical. No land, no fencing required; and very little labor.

2 The nuts are safe from the attacks of anay (termites); also from wild bears, goats, and other animals.

3. Germination may be made to conform to the right time for transplanting, for with this method the germination of the nuts is within control. It can be hastened by watering and can be retarded by limiting the amount of water poured on the seeds

4. The growth of the shoot is normal while that of the roots is very slow. The roots are not injured before transplanting as is likely to occur in digging the seedling out of the ground. Thus no time is lost after transplanting by retarded growth because of injured roots.

Good as the Hanging Method appears to be it is not very extensively employed. The method commonly used on commercial coconut plantation is the Seed Bed Method.

The Seed Bed Method as its name implies involves the preparation of a piece of land for germination. To be well suited for a germination bed, this land should have certain specific qualities. It must be free from anay (termites) and from any other minute organisms that may attack the nuts or the seedlings in the ground. The seed bed must be well drained and near a source of an ample supply of water in time of drought for sprinkling or whenever watering is needed. Moreover, in order to save labor in transportation the proposed seed bed should be located near the main field where the seedlings are to be transplanted.

In planting the nuts in the seed bed, consideration should be given, (1) the arrangement of the nuts in the bed, (2) the distance between nuts and (3) the depth the nuts should be buried in the ground.

As to arrangement, although the nuts may be germinated without any definite arrangement in the seed bed, yet it is very convenient to place the nuts laid side by side in straight rows, forming square plots of about 3 meters by 3 meters or rectangular plots or beds 3 by 2 meters each. A footpath between plots of about a meter in width should be made to use in making inspection, watering, and in selecting vigorous seedlings for transplanting. This scheme is advisable if the seedlings are expected to be transplanted early.

Other schemes of preparing the bed may be followed. The nuts may be arranged also in straight rows, but, in this case, the rows should be set rather far apart. The distance between the rows of nuts and the distance between the nuts in a row should be determined by the age at which the seedlings are transplanted. In no case should the distance between the rows exceed one meter, for it is not usually desirable to allow the seedlings to grow with the shoot longer than about 30 centimeters. The seeds should be set in the row rather close together and the distance between the rows should be about 25 centimeters or enough to allow a person to pass. The space between the rows may serve also as a secondary drainage canal.

The depth of setting the seeds in the bed is governed by the length of time the seedlings are to be left there before transplanting, and to a less degree is governed also by the physical character of the soil and the climate of the locality. In loose soil and if the seedlings are to be allowed to grow tall, the nuts should be entirely or almost buried in the ground. On the other hand, if seedlings are to be transplanted at less than about 30 centimeters in height, the nuts may be two-thirds, one-half, or one-third buried in the ground. To obtain a rapid germination, however, the nuts should be entirely buried. This method is also advisable if the drying influence of the air is great around the seed bed. The nuts then will be in the ground and the shells prevented from cracking, a condition which is oftentimes the cause of the death of seedlings or the failure of the nuts to germinate. This result was observed in the present study where the husks of the nuts were either partly or entirely removed. The shells of most of the nuts that received this treatment cracked. The seeds failed to germinate or, if they did sprout, the seedlings did not continue to grow. Micro-organisms, which according to our casual observation were either bacteria or fungi or both kinds, attacked the cotyledon as well as the endosperm. This caused decay.

The Jaffna Method practiced in the northern part of Ceylon is essentially the same as the seed bed method practiced in the Philippines, except that in the Jaffna method the seedlings are transplanted to a nursery bed for further growth before planting in the permanent plantation. It would appear that unless labor is cheap this method is not practicable and the transplanting of big seedlings is undesirable.

The Direct-to-Field Method involves the preparation of no seed bed or nursery bed. The nuts before they germinate are set directly in holes in the permanent field. This method saves labor but does not insure either rapid or uniform

germination of the nuts. In fact, the germination under this condition is rather slow and a good many nuts usually fail to germinate. The nuts are subject to attacks of anay and also by wild hogs. Should this method be practised it is advisable that a small nursery bed be established and the seedlings from this be used in filling out vacant hills in the plantation.

In the present study no attempt was made to try all or the different methods of germination of coconut seeds herein described. The Seed Bed Method only was employed.

II. MATERIALS AND METHODS

A nursery bed was prepared for this study out of one of the plots on the College Farm. On April 14, 1920, seeds of Laguna type of coconuts were laid on plot, about half buried. One or two of the husked nuts, being small, were entirely covered with the soil by the rain that fell while the experiments were in progress. Consequently as these nuts were protected their shells did not crack with the result that germination was rapid.

The nuts used were of the same variety but in two distinct stages of development. One set of sixty had green husks and another set of sixty had dry husks. With this limited number of nuts, it was possible to include only 12 dry-husk nuts and 12 green-husk nuts in each of the five kinds of treatment. The nuts were treated as follows:

1. Nuts with top end up.
2. Nuts with top end down.
3. Nuts lying on the side.
4. Nuts with one-fourth of the husk removed and lying on the side.
5. Nuts with entire husk taken off.

During the first days this study was in progress some of the nuts were watered every day; with the object of ascertaining the influence of watering on the rate and percentage of germination, but in the latter part of the time rain fell making it impossible to continue this phase of the investigation. With the climatic conditions existing on the College Farm it is almost impossible to carry out an experiment of this kind even during summer days unless the nuts are placed along the sides of the building, or in a glass house, or some sort of shelter can be spread over the nursery bed whenever the rain is falling.

Before presenting the results of this study, it should be emphasized that the nuts, the growth data of which are presented in each horizontal column of figures in Table I, were apparently uniform in size and shape,—some came from the same bunch or cluster and the others were expressly selected for uniformity in size and shape and degree of ripeness. The difference in results obtained was apparently due to the difference in treatment given the nuts and not to any difference that was discernible in the nuts.

III. DISCUSSION OF RESULTS

On September 10, 1920, about five months from the time the seeds were placed in the seed bed a final observation on the apparent condition of the seed-

lings and of the nuts that failed to germinate was made. Likewise measurement of the height of the tallest leaf of each seedling was made. The data obtained are presented in Tables I, II, III.

Table I shows the height of the tallest leaf of each seedling; and the nuts that appeared normal at the end of the experiments but had not yet germinated. These are presented by *O*. The nuts that died and those that were lost are indicated in the table by *d* and *l*, respectively. Nuts that were husked, especially those that cracked, were the ones lost. Since the majority of the husked nuts lost were cracked, they did not germinate well or failed to sprout completely. The loss was not serious and does not lessen the value of the results obtained.

The data in Table II are the arbitrary values of the data in Table I. In Table II the height of the shoot between 90 centimeters and one meter is considered *1;* between 80 and 90 centimeters, *2;* 70-80, *3;* 60-70, *4;* 50-60, *5;* and *0* for heights below 50 centimeters. The nuts that were lost and those that died are indicated in the table with *l* and *d*, respectively. A summary of the values in Table II is shown in Table III.

TABLE I.—*Length of the tallest leaf of each seedling.*

Nut No.	Husked nuts.		One-fourth husked nuts		Unhusked nuts					
					Top down		Side down		Top Up	
	Dry.	Green	Dry.	Green.	Dry.	Green	Dry	Green	Dry	Green
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1	69 5	*l* [c]	*d* [b]	*d*	defor-med	1 0	83 0	24 9	49.0	39 5
2	19.5	3 1	*l*	*d*	61 0	0 [a]	20.6	67 4	30 0	26 0
3	66.2	*d*	*l*	*d*	62 0	*d*	82 6	*d*	39.3	*d*
4	*l*	*l*	70 4	*d*	defor-med	*d*	74.4	*d*	58 0	17 0
5	25.0	*l*	*d*	*d*	84.0	*d*	89 5	58 5	46 7	8 7
6	34.2	*d*	*l*	*d*	104 9	13.2	97 8	62.8	37 0	4.9
7	81.0	*d*	*d*	*d*	0	0	88 5	66.4	27.5	19 5
8	*l*	34.6	*d*	*d*	71 4	0	82 5	61.7	*d*	1 0
9	*l*	*d*	*d*	*d*	30 6	0	71 0	29.6	48 0	8 5
10	*l*	38.0	*l*	*d*	0	0	*d*	43.0	30 5	*d*
11	94.4	*d*	*d*	*d*	0	*d*	61 4	*d*	43 1	22 0
12	*l*	*d*	52.6	*d*	0	*d*	*d*	65 7	*d*	*d*

a the shoot alive; still buried in the husk.
b dead.
c lost.

TABLE II.—*Arbitrary values of data from Table I.*

Nut No.	Husked nuts.		One-fourth husked nuts.		Unhusked Nuts. Top down.		Unhusked Nuts. Side down.		Unhusked Nuts. Top Up.	
	Dry.	Green	Dry.	Green	Dry.	Green.	Dry.	Green.	Dry.	Green.
1	4	*l* [a]	*d* [b]	*d*	0 [c]	0	2	0	0	0
2	0	0	*l*	*d*	4	0	0	4	0	0
3	4	*d*	*l*	*d*	4	*d*	2	*d*	0	*d*
4	*l*	*l*	3	*d*	0	*d*	3	*d*	5	0
5	0	*l*	*d*	*d*	2	*d*	2	5	0	0
6	0	*d*	*l*	*d*	1	0	1	1	0	0
7	2	*d*	*d*	*d*	0	0	2	4	0	0
8	*l*	0	*d*	*d*	3	0	2	4	d	0
9	*l*	*d*	*d*	*d*	0	0	3	0	0	0
10	*l*	0	*l*	*d*	0	0	*d*	0	0	*d*
11	*l*	*d*	*d*	*d*	0	*d*	4	*d*	0	0
12	*l*	*d*	5	*d*	0	*d*	*d*	4	*d*	*d*

a 1 = lost.
b d = dead.
c 0 = below 50 centimeters in height.
Value for figures, see text pages *12 and 13.*

TABLE III.—*Summary of Table II*[1] *showing the frequencies under the different germination grades.*

Germination grade	Husked nuts		One-fourth husked nuts		Unhusked nuts Top down.		Unhusked nuts Side down.		Unhusked nuts Top Up	
	Dry	Green	Dry	Green	Dry.	Green	Dry	Green	Dry.	Green.
1	1				1		1			
2	1				1		5			
3			1		1		2			
4	2				2		1	5		
5			1					1	1	
0	3	3			7	7	1	3	9	9
d		6	6	12		5	2	3	2	3
l	5	3	4							

[1] Explanation of table on text page *88*.

The first vertical column in Table III represents what might be called the *germination grade* in this study. The actual values of the figures in this column are described in the preceding paragraph. The other figures in the table repre-

sent *frequencies* under the different *germination grades*. Discussion of the results obtained from this study are given in the following paragraphs under separate headings.

a. *Ripe and unripe nuts for seed compared.*—The results from this study confirmed conclusively the opinion of some writers, that dead ripe nuts are best for seeds. The data in Table III show that although more dry nuts than green ones were lost, the germination of the ripe nuts was about 100 per cent greater than of the green-husk nuts. The ratio of the failure in germination was about 1 to 3. In other words, more seeds with green husk failed to sprout than those with dry husk. It should, however, be borne in mind that some green-husk nuts about one-half full of water germinated, but the rate was rather slow and the percentage of viability was low.

b. *Husked and unhusked nuts compared.*—A prominent scientist once said to the writer that some one reported that a better result was obtained in germinating coconuts when a certain part of the shell was filed and made thin than when the nuts were germinated without receiving this treatment. Up to the present the writer has not found any experimental evidence supporting this opinion and according to results obtained in the present study it would seem to be not well founded, unless other special treatment was given the seeds,—as entirely burying them in moist soil or a constant supply of water. In this study some nuts were either entirely or one-fourth husked. The nuts were supposed to be one-half buried in the ground. Two entirely husked nuts (see Table I, Nos. 7 and 11) were accidentally completely buried in the ground. The result was rapid germination and vigorous growth of the seedlings. Where the nuts were not completely buried in the ground, the results observed were slow germination, and the shells of most nuts here tested, cracked. Although one or two nuts with cracked shells did succeed in germinating yet the majority failed to germinate at all. These nuts were split open, some showed that the cotyledon was rotting and others showed that the meat or endosperm, as well as the cotyledon was decaying. The causal organisms were either fungi or bacteria or both. It is, therefore, safe to recommend that unless the nuts for seed should receive special attention that would prevent the shells from cracking, they should never be husked before planting.

c. *Influence of position of nuts on germination.*—Detailed examination of the data obtained from unhusked ripe nuts reveals the fact that although germination was possible irrespective of the position of the nuts in the seed bed, yet the nuts placed lying on their side was found in the present study to be the most practical and desirable. This result is in conformity with the recommendation made by Barret (6) by Copeland (1), and by Wester (7).

The majority of the nuts placed *top down*, although they did not fail to germinate had deformed shoots. Also, the coming out of the shoot through the husk was greatly delayed. Six nuts out of twelve had either a deformed shoot or the latter was still buried in the husk when this study was ended.

The nuts that were set in the nursery bed *top up* germinated, but the rate of germination was slow,—much slower than the germination of the nuts placed *side down*. The reason for this delayed germination was that the growing cotyledon in the shell was not amply supplied with moisture. If moisture was provided at all, it was in the form of water vapor arising from the body of coconut

water in the nut and was supplied from or through the meat, or endosperm. The development, therefore, of the cotyledon, or the food-absorbing organ of the seedling from the store of food in the nut, was not as fast as it could be if the latter were amply provided with the coconut water. Numbers 1 and 5 of Fig. 2, Plate I, show the cotyledon of the germinating nuts. In No. 1 the cotyledon was just beginning to develop. The water in the nut, which at this stage was one-third sufficient to fill the cavity in the shell, could not reach the cotyledon. There is a time when coconut water is sufficiently provided for the shoot; this water helps the cotyledon to grow; it is needed in the conversion of the insoluble food into soluble form; in the translocation of this food to points where new cells or tissues are formed; and making the body of the seedling in a turgid condition. The last is a condition essential for growth. In the latter development of the seedling water is also needed in photosynthesis, in the formation of carbohydrous foods. A great deal of this water, however, comes from the soil and is absorbed by the roots and not by the cotyledon or foot.

The most ideal position of the nuts for germination in the seed bed as already stated, is *side down*. The results of this study are summarized in Table III where the highest percentage of germination was obtained with the nuts lying on their *side*. The most rapid germination was also observed among the nuts in this position. As shown in Table III and according to *germination grade*, eight ripe nuts out of twelve tested obtained a grade beyond passing (or germination grades 1, 2 and 3). Only three nuts placed *top down* obtained the *passing mark*, while those that were placed *top up* made no *passing mark* at all. These results show conclusively the advantage of placing the nuts *side down* over placing them *top down* or *top up*. An explanation of this advantage may be found in the fact that when the nuts are placed on their side, the growing cotyledon can reach and absorb the water or liquid in the shell and the sprouting shoot finds it rather easy to push its way through the thin layer of husk composed of loosely connected fibers, near the top end of the nut. The little difficulty the shoot might encounter in passing through this portion of the husk may be removed, *not* by taking off all the husk or part of the husk as tested in the present study, but by slicing off, as recommended by Copeland, a portion of the husk in this case is near the top end of the nut, to take off the hard surface of the husk; this would diminish the amount of friction that might be encountered by the shoot in coming out of the husk.

d. *Time to transplant seedling as indicated by the meat.*—An attempt will be made here to explain the desirability of transplanting coconut seedlings before they develop shoots to height of 30 centimeters. This explanation will be based mainly on the thickness of the meat or on the amount of food still left in the endosperm for use of the growing seedling. Why ready food is needed by the seedling, at least during the first few days after transplanting, is probably well understood.

Irrespective of size of the shoot, this food is needed by the seedling because the roots of the latter are not yet established in the soil. It requires about a week, if atmospheric and soil conditions are favorable, or longer if not favorable, before the roots can in moderation properly absorb water and dissolved minerals from the soil. The roots grow rather slowly especially if they are disturbed in their connection with the soil. In Laguna the roots grow, on the average, about 3.02 millimeters a day (*1*). It is then imperative that a certain amount of food be supplied the shoot and the root for maintenance and growth, while the shoot

and the root are unable to perform their respective functions of photosynthesis and absorption of soil water.

The nuts in this study were split open about the end of the fifth month in the seed bed. Accurate observations were made of the apparent condition of the meat in the shell. The important points observed may be summarized as follows:

1. The rate of absorption of food from the endosperm, judging by the amount of meat left after a period of germination, seems to depend not so much upon the duration of germination period as on the vigor of the seedling. The nuts were put in the seed bed at the same time and they were split within the same hour; the degree of development of the shoot seems to be correlated with the amount of food absorbed by the cotyledon from the endosperm. The vigor or size of the shoot or plumule depends upon the external climatic and soil conditions present during germination and upon the amount of liquid food supplied to it by the cotyledon from the endosperm, which, in turn, depends upon the degree of development of the cotyledon. The rate of growth of the cotyledon depends upon the amount of liquid materials supplied to it from the nut, which in turn again depends partly upon the position of the nut during germination; amount of water absorbed by the roots from the soil; and upon some unknown conditions.

2. The right time to transplant coconut seedlings as indicated by the meat content in the nut, seems to be when the shoot or plumule is from 15 to 30 centimeters in height. Copeland seems inclined to recommend the 15-centimeter height for transplanting. At this stage of the development of the seedlings the endosperm is still very thick. Observations made in this study showed that when the plumule was about 30 centimeters long, the food content of the endosperm was still large. When the plumule reached a height of about one meter, the endosperm was almost entirely absorbed by the cotyledon. Therefore, unless *absolutely necessary*, as when the field is not yet ready for planting or the seedlings are intended for filling out vacant hills in the field, the seedling should never be allowed to develop a shoot as long as one meter.

IV. SUMMARY OF CONCLUSIONS

The present paper is based on results obtained from a set of experiments carried out by a class on Oil Plants in this College. The number of the nuts used was small but the results obtained are fairly reliable and conclusive and in conformity with the belief given by some writers of authority on the subject. The following points may be considered fairly well established:

1. Dead ripe nuts for seed are superior to nuts at any other stage of ripeness or development. In case of *absolute necessity* green-husk nuts may be used for seed. The water in the nuts must, however, shake readily.

2. Unless the nuts for germination are to be buried in the soil or are to be amply watered, partial or complete husking is undesirable. The shell cracks quite easily when the nut is husked, and is usually the cause of most failures of nuts to germinate or of later death of the seedlings.

3. The best position for placing the nuts is *on the side*. This position is commonly followed in seed beds and also when germinated out as by the Hanging Method.

4. The desirability of transplanting the seedlings when the latter have shoots not exceeding 15 centimeters, as recommended by Copeland, or 30 centimeters as found here possible, lies in the facts: (1) that the meat content of the nut at this time is plentiful, (2) the roots are short and (3) the shoot is also short.

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ALUMNI AND COLLEGE NOTES

Toribio Vibar, '12, a university fellow in crop production, is now studying for the degree of Doctor of Philosophy in Agronomy at the University of Illinois. He writes that he completed all requirements except the thesis, and that he expects to return in August of this year.

Edgar M. Ledyard, '13, is at present Director of the Agricultural Department of the United States Smelting, Refining, and Mining Company. He obtained the degree of Master of Science from the University of California in 1915, and has been in his present position since then. Mr. Ledyard was one of the first members of the faculty of this College.

Eladio Sablan, '14, is Assistant Agronomist in charge of Fiber Investigations in the Bureau of Agriculture. Mr. Sablan was recently married to Miss Encarnación Santana of Pasig, Rizal. Mrs. Sablan is a senior student in pianoforte in the Conservatory of Music of the University of the Philippines.

Elias H. Pangañiban, '15, a special fellowship student of the University, in Chemistry, is now attending Cornell University. His present address is 123 Quarry St., Ithaca, New York, U. S. A.

At a special meeting of the College of Agriculture Alumni Association held in Los Baños College on December 14, 1922, the association unanimously passed a vote of congratulations to its President, Professor Inocencio Elayda, M. S. '16, now Director of Extension, for his success in bringing about a closer coöperation between the different farmers in the province of Laguna as a result of the first Laguna Farmers' Day held in the College of Agriculture on November 30, 1922. The association also went on record in expressing its willingness to coöperate wholeheartedly with the College of Agriculture and its Extension Agency to make future farmers' days successful.

The College of Agriculture exhibits at the University Day held in Manila on December 12, 1922, attracted quite an attention of the visitors. Mr. Pedro David, '19, of the Agronomy Department, was in charge of the exhibits. He was assisted by Mr. Felix Esguerra, '22, of the Extension Service of the College.

Hilarion G. Henares, B. S. C. E. '19, a graduate of our College of Engineering, and now employed as instructor in Sugar Chemistry of this college, was recently elected member of the College of Agriculture Alumni Association. Mr. Henares was a pensionado from the College of Engineering in the United States

and specialized in Industrial Engineering. He graduated from the University of Illinois with the degree of Bachelor of Science in Mechanical Engineering in 1921. After graduation, he went to Louisiana State University to specialize in Sugar Chemistry. He has had an extensive practical training in Factory Management, and on his return, a number of months ago, he was detailed to the College of Agriculture to complete the Sugar Mill which was christened during the Farmers' Day on November 30, 1922.

Arsenio Goco, '17, is now starting citrus and truck farming in Salawag, Das Mariñas, Cavite. He informs us that there are still several hundreds of hectares of Friar Lands available near Manila. These lands range from one hundred to two hundred pesos a hectare, payable in installments for a period of nine years. Mr. Goco is also an employee of the Bureau of Agriculture.

Mariano E. Gutiérrez, '17, writes that he is "still alive," and is working gradually for his own "economic independence". He is at present Chief Agricultural Assistant, and his present address is Pikit, Cotabato.

Eduardo Quisumbing, '18, a university pensionado, specializing in Botany (Morphology and Ecology) in the University of Chicago, is a candidate for Doctor of Philosophy, which degree he expects to obtain very soon. He obtained his Master of Science in the same university in 1921. He has been elected to active membership in the Society of the Sigma Xi, Chicago Chapter, an honorary scientific fraternity. Mr. Quisumbing is also a member of a number of other organizations, among which are The Botanical Society of America, The American Genetic Association, and the American Association for the Advancement of Science.

Melecio M. Manio, '19, who was formerly a Technical Assistant and Deputy Provincial Governor of Lanao, is now teaching in the Provincial High School of Nueva Ecija. His present address is San Isidro, Nueva Ecija.

Domingo S. Baybay, '21, is with the Bureau of Agriculture, stationed in La Carlota, Negros Occidental. He is in charge of the fiber cultures in that station.

Moises S. de Grano, '21, is now Technical Agricultural Assistant in Butuan, Agusan. In that capacity, he has the opportunity to travel throughout Agusan. He writes in part as follows:

> "The travelling official here should always be on the alert in order to make his trips on schedule. There is no provincial road, but the Agusan River serves as such. In going around the province, the traveller should provide himself with enough food, for in the remotest parts of Agusan one cannot buy anything except camote, and, in some cases, not even this could be bought."

Baltazar Corcino, '22, is at present a teacher in the provincial High School of Capiz.

Agapito E. Buenaventura, '22, is at present an instructor in Animal Husbandry and Horticulture in the Catarman Agricultural School, Catarman, Samar. He writes that he is making a success of his budding work on citrus and other plants.

"The Ranchers' Club," an organization composed of students majoring in Animal Husbandry, gave its first program on December 14, 1922, at the New Animal Husbandry Building. The program consisted of music and talks given by some of the members of the Animal Husbandry staff. In connection with the program, the members enjoyed a little dinner "on banana leaves". The affair was marked with a brilliant spirit of coöperation among the members, all of whom were kept busy by Ranchers Manuel, '24, and Limuaco, '24, who were in charge of the preparations of the dinner and of the table respectively. Some of the members of the Animal Husbandry Staff gave talks and pledged to help the club in order that the objects for which it has been organized may be realized. There was also music which added a lot to the excitement of the crowd. The party disbanded about 9:30 in the evening and everybody thought that no party could have been more successful than this. Dániel B. Pena, '22, is the Governor of the Club, and Dr. F. M. Fronda, a member of the Animal Husbandry teaching staff, is the Adviser.

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A TENTATIVE STUDY OF THE EFFECT OF ROOT EXCRETION OF COMMON PADDY WEEDS UPON CROP PRODUCTION OF LOWLAND RICE.[1]

By F. DE PERALTA AND R. P. ESTIOKO
of the Department of Plant Physiology

INTRODUCTION

Crop rotation does not always insure a better return than that which could be obtained by growing the same crop continuously. The result of the work of W. M. Hays (1) shows that

> "A four-year rotation—millet, barley, corn, and oats—gave no better returns than wheat grown continuously."

The above finding could be explained as being partly due to root excretion. This conclusion is supported by the contention of O. Schreiner and H. S. Reed (2) that

> "In our present state of knowledge it would seem that we must regard the excreta of growing roots as one of the main causes of the low yields obtained in unproper crop rotation."

This is further justified and supported by F. Fletcher, B. E. Livingston, and I. Stocklasa, and A. Ernest (3), (4) and (5) that roots of plants excrete a substance which is injurious to other crops. It appears therefore that root excretion is an important factor in crop production. A knowledge of the kind of crop which should follow another crop in order to get a fair return is undoubtedly valuable information to have for reference. It was the object of this work to find out as far as possible and to try on several kinds of plants the effect of root excretion when the aqueous extract of the soil where the plants are growing is supplied to another crop.

The work was carried out at the College of Agriculture, Los Baños, during the year 1922.

MATERIALS AND METHOD

EQUIPMENT USED

Five petroleum cans, opened at one end and afterwards thoroughly cleaned with water, were used as containers for planting different species of weeds. Another six cans were also prepared for planting rice. To one of the corners at the

[1] Experiment Station Contribution No. 109

bottom of each of the five cans a hole was bored. A single holed rubber stopper was then fitted to each of the holes. Through the hole of the rubber stopper, a glass tube about ten centimeters long was inserted. To its lower end another glass tube about thirty centimeters long was connected to it by means of a piece of rubber tubing provided with a pinchcock. The arrangement and designation of the cultures as well as the method of obtaining the drainage from the can cultures are shown by the following diagrams. See figures 1 and 2. The experiment was carried in quadruplicate cultures.

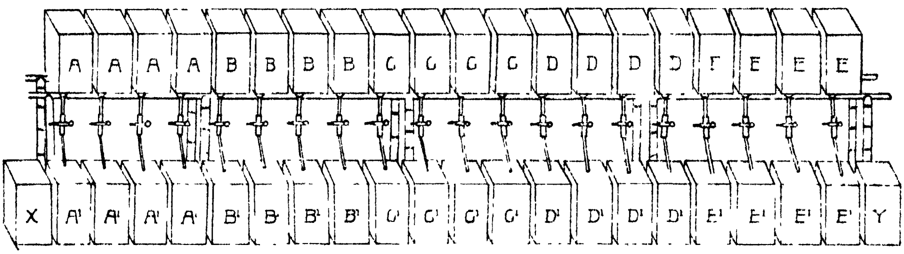

Figure 1, showing arrangement of cultures

A - Cans without any plant (Blank) A' - Cans planted with rice.
B - Cans planted with rice. B' - Cans planted with rice
C - Cans planted with zacate C' - Cans planted with rice
D - Cans planted with water lily D' - Cans planted with rice
E - Cans planted with *Cyperus* E' - Cans planted with rice
X & Y: Cans planted with rice and watered with tap water (Control)

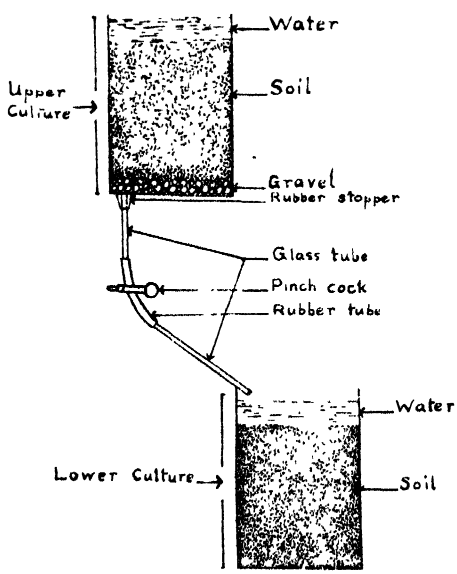

Figure 2.

For clearness, the cans labeled A, B, C, D, and E and placed on the stage as shown in Fig. 1 were designated as "upper cultures." Cans labeled A^1, B^1, C^1, D^1, and E^1 and placed below the upper cultures were likewise called the "lower cultures."

(a) *Kind of soil used.*—A typical garden soil (clay loam) was used for this study. The soil was taken from the college farm just east of the Botany-Physics building of the College of Agriculture. The soil was thoroughly pulverized and afterwards mixed before putting it into the cans. Eighteen kilograms of soil was put into each of the cans in the quadruplicate cultures.

(b) *Plants used and their preparation.*—Zacate (*Leersia hexandra* Sw.), water-lily (*Monochoria hastata* (L) Solms.), *Cyperus* spp. (sedges) and rice (*Oryza sativa* L.) all of which, except rice, are very abundant weeds in paddy fields, were selected from the field and planted in the upper cultures. These can cultures (upper culture) were planted quite thickly as there was room for the plants. The planting was done very much ahead of time before the lower cultures (A^1, B^1, C^1, D^1 and E^1 and XY) were planted with rice. The idea was to have the plants planted in the upper cultures well started for normal development before the rice plants planted in the lower cultures needed water for irrigation. Eight rice seedlings (two weeks old), uniform in height and number of leaves developed at the time of planting were planted to each of the cans in the lower cultures. Later the number of plants in every culture was reduced to two.

A lowland variety of rice was used as subject of this study. It was chosen because rice is the most important cereal in the Philippines. The effect of aqueous extracts obtained from the upper cultures in which zacate, water-lily, *Cyperus* and rice plants were then growing, were tried for watering rice, because the above named plants with the exception of rice practically always grow side by side with rice.

EXPERIMENTAL TECHNIQUE

(a) *Method of watering.*—Since the plants planted in the upper and that of the lower cultures were all aquatic plants the authors tried to maintain a depth of water of from eight to ten centimeters above the surface of the soil in the upper cultures and of from three to five centimeters above the surface of the soil in the lower ones. Water taken direct from the water pipe was used for watering the upper cultures and the lower cultures were in turn watered from the aqueous extracts obtained from the upper cultures as illustrated in Figs. 1 and 2. The cultures labeled X and Y, placed in line with the lower cultures, were set as controls. They therefore were watered with water taken direct from the water pipe.

(b) *Treatment of Cultures.*—All the plants in the lower cultures and labeled "A^1" received drainage from the upper cans labeled "A". In these cans, "A," there were no plants grown in the soil (Blank). Cultures labeled "B^1" received drainage from cultures labeled "B," containing rice plants; cultures "C^1" received drainage from cultures "C" containing zacate plants; "D^1" cultures received drainage from "D" cultures containing water-lily plants; "E^1" cultures received *Cyperus* drainage from "E" cultures; and cultures X and Y were watered with top water (water from pipe). See figs. 1 and 2.

(c) *Criteria considered.*—The total leaf product (length times width), dry weight of straw and grains and height of plants at the time of harvesting the plants from the different cultures were the criteria here considered for this study. The

height and total leaf products were intended to show the vegetative growth of each of the cultures and that of the dry weight of straw and grains were to show the total activity of the rice plants in response to the condition under which the plants were subjected.

RESULTS

The results are presented in tables as follows:

Table I shows the data of the different criteria considered from the individual cultures as affected by different kinds of drainage from different kinds of plants.

Table II shows the average comparative yield of the different cultures receiving different kinds of aqueous extracts as drainage from different kinds of plants.

Table III is a summary table showing gain or loss in leaf product (length times width), dry weight of stalks and grains in grams and total height of plants expressed in percentage of the different cultures watere˙ with different kinds of drainage.

DISCUSSION OF RESULTS

Table II, a condensed table of yield data of the different criteria considered from the different cultures as watered with different kinds of drainage, Table I, shows that water-lily and *Cyperus*, both very common paddy weeds excrete some substances beneficial to rice production. Zacate, the most common forage crop in the Philippines, according to results obtained, gives off some substances deleterious to rice. Likewise, rice excretes substances harmful to rice. This justified the results of S. Pickering that

> " * * * a plant affects its own kind just as much as any other kind; and hence we must conclude that the toxin formed by any individual plant will affect that individual itself."

In order to show the relative effect of the different kinds of drainage obtained from the different kinds of plants upon rice, the results obtained from the different cultures were expressed in percentages. Table III shows the gain and loss in per cent in leaf products, weight of straw and grains, and the height of plants at the time when they were harvested. It should be noted, however, that the cultures drained with water taken direct from the water pipe and labeled top water under the heading, "Sources of extracts as drainage," were the ones considered in this experiment as control. The results obtained from the control cultures were given a value of one hundred per cent. The value of the results obtained from the other cultures as watered from the different kinds of drainage in terms of percentages were obtained as follows.

Test[a] yield divided by control yield multiplied by 100 gives the value of test yield in terms of per cent, thus—Control yield (Top water) leaf product = 371.4 sq. cm. Test (soil drainage) leaf product = 466.7 sq. . cm.

$$\frac{466.7}{371.4} \times 100 = 126\%$$

The other criteria were calculated like the above formula. The results of these calculations can be seen in Table III, third column under the heading "Data obtained expressed in per cent".

[a] Test in this case means the culture watered with some drainage (aqueous extracts) as soil drainage, rice drainage or zacate drainage.

Having expressed the results obtained in a common unit, direct comparison can now be made. The authors tried only to consider leaf product, dry weight of straw and grains, and height of plants as the different criteria for this study. Before coming to column "gain and loss" we would like to mention the fact that in the soil undoubtedly there are also many kinds of bacteria and also of the lower plants such as algae. These organisms may in the course of the experiment modify the condition of the medium used. If this happens then we have two unknown factors involved, the substance excreted by the roots of plants in the one hand and the working of the soil bacteria, etc., in the other. In order that we could at least separate the effect of the two unknown factors mentioned above we had also set of cultures watered with soil drainage. No plants were allowed to grow in the soil. In this case the extract which we got from it was supposed to contain only the working of soil bacteria, etc., if there is any. The other cans where the different weeds were planted such as Zacate, water-lily, *Cyperus* and that of rice, the drainage which we took from them as aqueous extracts may contain the two unknown factors (Bacteria, etc., and Root excretion). For the present study we found out that by using soil drainage upon rice, the extract increases the leaf products of the plant 26 per cent over the leaf products of the control plants (top water); 62 per cent in dry weight of straw over the control plants; 91 per cent in dry weight of grains over the control plants; and 4 per cent in the height of plants over the control. From these figures it is safe to say that if soil drainage (aqueous extracts) is taken and watered to rice plants, a noteworthy gain could be obtained in any of the criteria mentioned over plants watered with top water.

Having known the effect of soil drainage (the working of soil bacteria, lower plants, etc., in the soil) in terms of percentages upon rice we can proceed to show whether the weeds used in this experiment had excreted some substances beneficial or harmful to rice.

Under the main heading "Leaf product in sq. cm., sub-column, Per cent, gain and loss," Table III, we see that for rice drainage we got a loss of 8 per cent. This figure was obtained by subtracting 26%, the value of soil drainage over the control plants (Top water) from 118, the value of the data from cultures watered with rice drainage, the result of which is 92% (representing the effect of the working of bacteria, lower plants, etc., in the soil) was subtracted from 100% (the value of the yield of the control plants) giving a deficit of 8 per cent. This eight per cent therefore represents a loss upon leaf product by rice if the plants are watered with rice drainage (aqueous extracts). In short, toxic effect of rice upon rice. The other figures under this heading, "Per cent gain and loss" and for the other criteria as for straw, grain and height of plants were calculated like the one just explained. The figures referred to are shown in Table III and graphed as illustrated in Fig. 3.

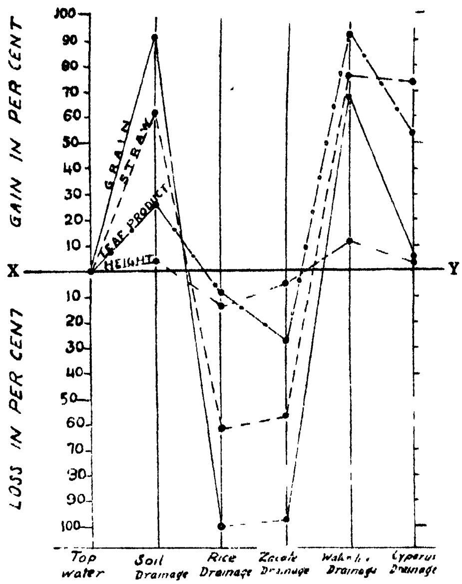

Figure 3.

Fig. 3 shows gain and loss in per cent. For convenience, line XY represents control yield of the four criteria considered, leaf products, dry weight of straw and grain, and height of plants. Any point below line XY shows loss and that points above it also show again. Examination of the graphs of grain, straw, leaf products and height of plants shows that the graphs follow the same trend. Rice and zacate drainage show conclusively that plants excrete some substance deleterious to rice production, while Water-lily and *Cyperus* show a big gain. These results suggest that zacate should not be rotated with rice and that water-lily and *Cyperus* insure a promise of better yield if they are rotated with rice. With special reference to grain yield, rice drainage to rice showed a loss of one hundred per cent in grain production. This is still higher than the effect of zacate drainage upon rice. One hundred per cent loss in grain yield in this case shows the degree of root toxicity of rice upon rice. However the toxicity of root excretion is to some extent counteracted by the working of soil bacteria, etc., as algae in the soil. In this particular experiment, the effect of rice drainage upon rice is reduced to nine per cent. Nine per cent therefore is the actual loss we get for every crop if rice is grown continuously in the same field. This loss is so slightly felt in the field that only after many years have passed do we find that the yield of rice grown in that particular place has depreciated appreciably.

CONCLUSION AND RECOMMENDATION

With regard the results obtained so far show conclusively that *Cyperus spp.* and water-lily (*Monochoria hastata* (L) Solms.) excrete substances beneficial to rice production and that zacate (*Leersia hexandra* Sw.) gives off also substances detrimental to rice production. Rice itself excretes a substance harmful to its own kind. As tentative conclusions of the results of this investigation are concerned, the authors strongly believe the following:

1. If water-lily and *Cyperus*, both very common paddy weeds, were grown in rotation with rice a noteworthy gain in rice production could be obtained.

2. Zacate which is the most common forage crop in the Philippines, should not be rotated with rice.

3. That rice also excretes a substance deleterious to its own kind causing a reduction of 9% in grain yield every planting in the same field, and that

4. Before planting rice thorough plowing and harrowing of the field should be done in order to have the toxic substances destroyed, thus rendering them to some extent harmless to the following crop.

ACKNOWLEDGEMENT

The authors wish to thank the members of Botany II Class (1922-1923) for their help in carrying up this experiment and to Professor D. A. Herbert for his criticism in the preparation of this manuscript.

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TABLE I.—*Yield data, number of bearing culms, length of panicle and height of stalks obtained from the different kinds of drainage of different kinds of plants.*

Different criteria considered.	Top Water		Soil Drainage				Rice Drainage				Zacate Drainage				Water-lily Drainage				Cyperus Drainage			
	Culture Number		Culture Number				Culture Number				Culture Number				Culture Number				Culture Number			
	1	2	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Number of bearing culms..	2	4	3	7	4	2	4	4	2	3	3	4	2	4	8	8	6	5	7	5	6	8
Average.	3		4				3 3				3 3				6.8				6.5			
Average length of panicle in cm..	19	20	16.0	20 5	20.1	9	18 6	17 0	12 2	11 8	18 1	16 5	14	19.1	17.0	19 0	20 8	20.4	21.0	18.0	19 1	18.1
Gen. Average	19 5		16.4				11 9				16 4				19 3				19 0			
Average height of stalk in cm..	93	99	98	108	102	90	105	109	68	66	94	106	80	102	102	114	113	110	100	104	100	106
Gen. Average.	96		99.5				87				95.5				111.5				102.5			
Total leaf products of all the culture in sq. cm.	371 4		466 7				437 6				366 4				814.0				668 1			
Weight of fresh stalks in grams	17 6	35 0	27.0	70 8	50.0	25.0	47 0	40.0	10 0	9 0	31 0	39 0	17.0	25.0	52.0	71.2	70.0	53.0	85 2	44.3	49 0	52.0
Average.	26 3		43.2				27 0				28.0				61.01				57 6			
Weight of fresh grains in grams.	3 56	8 6	6.0	23.6	10.02	3.9	11 6	7 25	1 55	1 5	5 7	7 4	3 1	4.4	13.3	16 9	12.3	16.7	14 2	9.7	6 4	13.4
Average....	6 08		10 88				5 47				5.2				14 3				10 9			
Dry weight of stalks in grams.	5.5	9.5	7 2	20.4	13.5	7.5	13 6	10 0	3.4	3 3	8.9	11.2	3.7	7.7	14.1	22.0	20 5	15.0	26.7	15.0	14.5	14.6
Average	7.5		12.2				7 6				7 9				17.9				17.7			
Dry weight of grains in grams.	2.85	6.57	4 9	18.4	9.2	5 1	8.95	6.0	1 22	1 2	4.9	6.55	2.35	3.8	10.55	13.9	10.6	13.65	12.4	7.92	5 3	11.04
Average	4.7		9.4				4.3				4.4				12.2				9.2			

Table II.—*Comparative data of average total leaf products (length times width) in sq. cm., dry weight of straw and grains in grams, total height of culms in cm. and number of bearing culms of quadruplicate cultures as drained by different kinds of aqueous extracts from different kinds of plants.*

Sources of extracts as drainage.	Leaf Products in sq. cm.	Dry Wt. of stalks in gms.	Dry Wt. of grains in gms.	Height of stalks in cm.	Average Number of bearing culms
Top Water	371.4	7.5	4.7	96.0	3
Soil drainage	466.7	12 2	9.4	99.5	4
Rice drainage	437.6	7.6	4.3	87.0	3.3
Zacate drainage	366.4	7.9	4 4	95.5	3.3
Water-lily drainage	814.0	17.9	12 2	111.5	6.8
Cyperus drainage	668.1	17.7	9.2	102.5	6 5

TABLE III.—*A summary table of gain and loss, in leaf products, dry weight of straw and grain, and height of plants of the different cultures as affected by different kinds of drainage from different kinds of plants expressed in percentages by using the data obtained from cultures drained with top water as control and considered to be as 100 per cent*

Sources of extracts as drainage	Leaf products in sq cm				Dry weight of straw in grams				Dry weight of grains in grams				Height of plants in cm			
	Data obtained	Data obtained expressed in per cent	Per cent gain	Per cent loss	Data obtained	Data obtained expressed in per cent	Per cent gain	Per cent loss	Data obtained	Data obtained expressed in per cent	Per cent gain	Per cent loss	Data obtained	Data obtained expressed in per cent	Per cent gain	Per cent loss
Top water	371.4	100			7.5	100			4.7	100			96.0	100		
Soil drainage	466.7	126	26(*a*)		12.2	162	62(*b*)		9.4	191	91(*c*)		99.5	104	4 (*d*)	
Rice drainage	437.6	118		8	7.6	100		62	4.3	91		100	87.0	91		13
Zacate drainage	366.4	99		27	7.9	105		57	4.4	93		98	95.5	99		5
Water-lily drainage	814.0	219	93		17.9	238	76		12.2	259	68		111.5	116	12	
Cyperus drainage	668.1	180	54		17.7	236	74		9.2	196	5		102.5	107	3	

(*a*) Effect of soil drainage upon leaf products.
(*b*) Effect of soil drainage upon dry weight of straw.
(*c*) Effect of soil drainage upon dry weight of grain.
(*d*) Effect of soil drainage upon height of plants.

BREEDING ORNAMENTAL HIBISCUS[1]

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The taste for ornamental plants and the ornamental garden is general among the Filipinos. Even in the most humble home, one may find evidence of this taste. From few to many varieties of plants may be found in a small lot constituting the ornamental garden, usually below the windows facing the street and along paths in the home yard. Where ground space is not available, plants are planted in pots and kept on special supports, sometimes in "azoteas"[2] or even in the windows and houses. The practice of hanging ornamental plants in front of windows is very general. The plants hung are usually orchids, but sometimes any other small type varieties are used. These are planted in pots and cans and then hung. Oftentimes these containers are very ugly, showing the simple taste of the owner. Even germinating corn ears are used as hanging ornamentals.

Excepting in comparatively few cases, this love for ornamental plants is easily satisfied as is evidenced by the fact that the family collection of ornamentals consists usually of very few varieties. The most common hanging plants used are the so-called "bird's nest" fern, *Asplenium nidus* L. and several varieties of orchids belonging to the species *Phalaenopsis* and *Vanda*. In the yard, the San Francisco (*Codiaeum variegatum* (L.) Blume.), the Gumamela (*Hibiscus rosa-sinensis* L.) and *H.schizopetalus* Hook, the Papua (*Panax fruticosum* L.) and Morado or Sarasa (*Graptophyllum pictum* (L.) Griff.) are most commonly grown. Besides these, a great variety of ornamental species is found cultivated in the Philippines. However, they do not go in a typical collection of the average family. One reason other more beautiful plants are not grown in general is that they are not as easy to secure and require greater cultural attention and care.

The greatest service of the plant breeder in the Philippines will probably be in the improvement of the few ornamental species generally grown and the bringing down into cultivation of the various ornamental plants now found in the mountains and the forests.

There is much in the way of ornamental garden improvement in the Philippines which students of Philippine plant breeding should learn besides the improvement of the ornamental plant itself. The beauty of a garden or a yard depends not only on the plants which are found in it but also on the arrangement and grouping of the plants, the contour of the land as well as on other minor factors. It is not the object of this paper to review even briefly the general subject of ornamental and landscape gardening or landscape architecture. It is necessary, however, that students learn some of the very fundamental points in the subjects as far as these may have a close relation to the improvement of ornamental plants. As the subject of ornamental gardening is, quite regret-

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[1]Experiment Station Contribution No. 110

[2]Asotea is an open floor usually at the back of the house. A sort of an upper story yard

tably, no longer taught in the College of Agriculture, although a beautiful and increasingly important garden is maintained, a few pertinent remarks about this are necessary to a proper understanding and appreciation of this paper.

An ornamental plant may serve any one or several of the following purposes: (1) For ornamental pot cultures, (2) for single plant ground cultures, (3) for hanging, (4) for ornamental hedges, (5) for table and mantle purposes, (6) for climbing effects, (7) for hiding undesirable views, (8) for lawns, (9) for mass effects, and (10) for fancy forms.

The first six uses find illustrations in Philippine ornamental gardening. The seventh use is hardly to be seen while the art of lawn making and the growing of lawn trees or plants as well as the art of obtaining beauty from special grouping or arrangement of plants and from pruning to get different forms of growth are practically unknown.

In many of the above uses, it is difficult to tell what characteristic appearance a plant should have. Much depends upon the taste of the grower. However, it is possible for a breeder to ascertain in each given case just what is desired of the ornamental plant. It is also practically certain that in most cases, novelty and fashion will be sufficient properties of a plant to find its way into the favor of the ornamental plant culturist. The creation of new varieties of ornamental plants should therefore be an important phase of the breeder's work.

The improvement or rather the conversion of common uncultivated plants into ornamentals, like the cultivation of wild plants of beauty, is important in itself. However, this is something that involves fashion and contempt for familiarity. A plant may be very beautiful but because it is not the fashion to use it as an ornamental or because it is very common, it is not cultivated as such. The breeder in this case may have to set the fashion himself. If he considers the work as remotely necessary he should bear in mind that the work of gathering, testing, and dissemination, among the growers, of the ornamentals now growing wild is of as much significance and importance as the introduction of foreign ornamental plants. When a foreigner interested in ornamental gardening visits a country, he anticipates seeing a garden characteristic of that country. If he goes to Japan, he desires and expects to see a Japanese garden. If he visits the Philippines he would like to see a Philippine ornamental garden and it will be not only to his disappointment but it will also speak poorly of Philippine originality if he finds the Filipino having a garden in which typical Japanese or Chinese plants predominate.

The present paper is the second attempt of the Division of Genetics of the College of Agriculture to create ameliorative interest in the most common Philippine ornamentals. The first attempt was a study of bud variation in the most common of these ornamentals, the Croton or San Francisco (*Codiaeum variegatum* (L.) Blume. The results of this study was reported by Mendiola and Magsino (1) previously.

The ornamental hibiscus is grown in the Philippines both for its ornamental value and for the medicinal use of the flower bud which is used in the treatment of boils. The hibiscus is one of the most common ornamental plants in this country and, as an ornamental, it is used in hedges extensively in the city of Manila and as individual plants throughout the Islands. In Hawaii, where apparently the greatest interest in this ornamental would be found, it is also used

as ornamental hedges or individual plants. According to Wilcox and Holt (2) whose paper has been cited somewhat freely in this work, there was formed in Hawaii, at one time, a Hibiscus Society and prizes tending to stimulate interest in the plant were offered. It is very probable that the richest collections of hibiscus varieties may be found in the Hawaiian Islands and it is a fact that many of the new varieties now growing in the Philippines are directly or indirectly of Hawaiian parentage.

SPECIES AND VARIETIES

In the Philippines.—Excluding the varieties which were introduced into the Philippines in 1920 and earlier and which at present are still being propagated in the College of Agriculture, there are, in the Philippines not more than three species and twelve forms or varieties of ornamental hibiscus. Of these probably not more than three are of very early introduction. These species are *Hibiscus rosa-sinensis* L., *H. schizopetalus* Hook. and *H. mutabilis* L. The first is the most common and widely found. Following is the description of these species and varieties. In the description of the varieties the locality mentioned is that in which the specimen described was found. It does not mean, however, that the variety is found only in that specific place.

Hibiscus rosa-sinensis. Gumamela or Gomamela. A shrub, plant dwarfish or one-third meter or less to three or more meters high, branches absent or are in profusion, generally vigorous; leaves smooth to rough, of various shapes, pale green to very dark green, margin may be entire or serrated or lobed or parted, 3 0 to 8 0 cm broad and 4.0 to 17 0 cm long, with a petiole 0.9 cm. to 4.0 cm. long, flowers axillary, 6.0 cm to 12 cm long, corolla 7 0 cm. to 15 0 cm wide, varies in color, various degrees of red, white, yellow, salmon and others, one-half of back different in color; petals short to long, narrow to very broad; staminal column usually longer than the corolla; anthers and stigmas may or may not have the same color as the corolla, bracts almost absent to very conspicuous; varies as to self-fertility. Flowers all the year round and best during and immediately after the rainy months

The following varieties may differ from one another in various respects besides in the color of the flower:

No 1 —Flower, red with single corolla, very common all over the Islands
No 2 —Flower, red with double corolla, found in Los Baños
No. 3 -Flower, white with single corolla, found in Lilio, Laguna
No 4 -Flower, pink with single corolla. Sometimes called Gumamela Loca
No. 5 --Flower, yellowish with single corolla, Silang, Cavite
No. 6 - Flower, red with multiple equally sized corolla, Silang, Cavite
No. 7. --Flower, red with multiple corolla, inside corolla smaller, found in Rizal and Laguna Provinces.
No. 8 --Flower, pink with multiple corolla.
No. 9 —Flower, light blue, single, reported in Baguio, Benguet, and Majayjay, Laguna Province.
No. 10 — Flower, with multiple corolla, red at noon, otherwise rosy white in color, very similar to *H. mutabilis* but smaller Found very common in Pagsanjan and Sta Cruz, Laguna
No 11 —Flower, rosy white, with red eye, single corolla, medium in size Found in barrio between San Pablo and Calawang, Laguna.
No. 12—Flower, double, white. Silang, Cavite.

H. schizopetalus. Gumamela de Araña or Araña. A shrub, several meters high, branches moderately, branches long and drooping, fairly vigorous, bark gray, petiole and side of twigs toward the plant reddish, leaves oblong-ovate or elliptic-ovate, acuminate, dentate, 4.0 cm to 8 0 cm. long, about 3 5 cm. broad with 1 0 cm. petiole; surface smooth, dark green, thick; flowers axillary, solitary, about 9 0 cm long, pendulous, with long peduncle; corolla about 6.0 cm wide, almost all red or with white linings; petals recurved, end split into lobes, or also into laciniae; staminal column about 9 0 cm. long, usually pale pink; stigmas scarlet red, anthers brownish, bracts not conspicuous; flowers all the year, hardly self-fertile.

Variety No. 1.—Flower, pale scarlet red, petals split into shallow lobes.

Variety No. 2.—Flower, red and yellowish white, petals often split into numerous slender lobes and laciniae

H. mutabilis. Amapola or Mapola. A tall shrub, about 3 meters high, branches moderately, bark gray; leaves broadly ovate to orbicular ovate, lobed, crenate; corolla single or double, flower bigger than that of any other ornamental hibiscus, pale pink or white, crimsons at midday and for this reason it is also called the "Flor de las Doce" which means twelve o'clock flower; flowers most of the year.

Hibiscus tiliaceus L., Balibago, which is found in the Philippines and reported as an ornamental hibiscus of Hawaii is not used as an ornamental here.

New introduced varieties.—On May 10, 1920, the College of Agriculture received bud sticks of 42 or more supposedly different varieties of hibiscus from Hawaii and they were grafted on several of the native varieties. Red, pink, white, and yellow colors of flowers are represented in the introduction. A number of the grafts failed but a good number succeeded in growing and they will furnish, as they have already furnished, valuable materials in hisbiscus breeding as well as become sources of materials in varietal introduction into different parts and gardens of the Philippines in the future, enriching in this way the old very limited collection. The introductions were numbered 12394, 12395, etc., to 12437 in the Agronomy Accession Book and may in the future be referred to by these numbers. There had also been other attempts at similar introduction before 1920.

Species and varieties reported in Hawaii.—Wilcox and Holt (1913) reported the following:

H. arnottianus, native, flowers white; *H. weimeae* native, flowers pure white; *H. kokio* native, red; *H. kahilii* native, red; *H. brackenridgei* native, sulphur yellow; *H. youngianus*, native; *H. tiliaceus* native; *H. rosa-sinensis* introduced; *H. schizopetalus* and *H. mutabilis*, also introduced.

All the native white, except *H. weimeae* are said to be cross-fertile with other varieties. *H. brackenridgei*, *H. youngianus* and *H. tiliaceus* do not cross with other flowers. The three introduced species named have been used in Hawaii in extensive hybridization.

VARIABILITY IN THE HIBISCUS

In color of the flower.—Majority of the varieties known are pink, or diluted crimson. Many varieties are scarlet pink. There are various shades and combinations of crimson and scarlet, tinged in many cases with yellow or orange. The "eye" in many varieties is blackish crimson. By "eye" of hibiscus flower is meant in this case the central visible area of the flower, formed by the central inside portions of the petals. In some varieties the yellow color so predominates that, viewed a few feet off the flower, this appears practically yellow. The veins, however, are pinkish. Instead of yellow, the color may be salmon in other cases. A few varieties are white, either pure or with colored veins or with crimson eyes. One blue variety has been reported in the Philippines, but this report has not yet been confirmed. It should be borne in mind that wilted or bruised flowers of the red varieties show a bluish tinge.

Shape of flower.—Flowers may be of either of three shapes. In one, the petals are more or less recurved and the edges of the petals are wavy and scalloped. An illustration of this shape is that of *H. schizopetalus*, or the Araña variety. The recurving, in other varieties, may begin from the base of the petals. This is the second shape. A third shape, which is the most common, is that of a funnel. This form remains in many varieties until wilting time; in others, in the first part of the day they are produced.

The petals vary in form, from linear or very narrow to decidedly broad; or from about a little over a centimeter to about seven centimeters in width and two and one-half to about twelve centimeters in length; some are straight while others are curved.

Time and duration of opening.—The hibiscus flowers nearly all the year, especially during and after the rainy season. Most varieties open in the early

morning and remain open for only a day. Others open at about 9:00 o'clock in the morning. *H. brackenridgei* opens only late in the afternoon. In some varieties, the flowers may remain open for two or even three days.

Habit of growth.—Hibiscus varieties vary from small dwarf shrubs to trees ten or more meters tall; from those which are thickly tufted and shrubby to those showing whip-like growth with few or no lateral branches. In some varieties the foliage is dense and the leaves are found throughout the wood, others have naked wood and produce leaves only near the tips of the twigs.

Leaf characteristics.—The leaf surface may be rough, or smooth, hairy or pubescent, dull or shiny. Some varieties have linear leaves, others lanceolate and ovate, while still others, orbicular. The margin varies from entire, through various degrees of crenation, serration and dentation, to deeply incised, three-lobed or completely three-divided forms.

Other characteristics.—The outside part of the petals, as these overlap in the bud stage, is different in color from the other part. The color is generally white, but it may also be yellow in other cases.

The eye varies in width from more than a centimeter to about eight centimeters, and has a darker color than the rest of the petal. The deep color of the eye may extend farther out on the petals into the veins, leaving lighter areas between the veins. The veins may be pink or white. When white, the throat is ordinarily white also. The staminal column varies in length from about four centimeters to about 15 centimeters. The column may be smooth in some cases, or pubescent in others. The filaments may be absent in other varieties while in others they may be more than 2 centimeters long. The stigmas vary in shape. Some are appressed together, others are divergent or at right or reflex angles with the column. The column may be stiff in some varieties, or pendulous in others.

METHODS OF IMPROVEMENT

These are (*a*) by introduction of new species and varieties, (*b*) by artificial hybridization, (*c*) by bud selection, and (*d*) production and selection of new seedling varieties.

Introduction of new species and varieties.—An example of this work is found in Hawaii. It is said that from all over the world varieties were collected and assembled in this country where they have furnished rich materials for hybridization and dissemination. Foreign varieties are necessary to the breeder specially in hybridization work. Before and since the American occupation of the Islands in 1900 there have been probably scattered attempts at introduction of foreign varieties into the Philippines by private enterprise. The College of Agriculture began the collection of different varieties found in the Philippines in 1910. In 1913 the first importation of foreign varieties was made when Professor Baker brought with him from Hawaii several varieties from that country. The latest and bigger importation was in 1920 also from Hawaii and made by Professor Higgins. As a result of these importations and the attempt to assemble native grown forms and the breeding work under report, there is now in the College cultures easily the richest collection of ornamental hibiscus in the Philippines. This collection is bound to give greater variety to the forms grown by private individuals.

Artificial hybridization.—The ornamental hibiscus is grown principally for its flower. The flower exists in many colors and color combinations, and this fact should make it easy for the breeder to get desired colors and combinations which it is possible to create. If a pure blue, pure green and pure black hibiscus could be produced, these should be of enormous value to the present collections of hibiscus known.

The technique of hybridizing hibiscus is very simple and easy because the flower and its parts are large and easy to handle. While the hibiscus flower is always perfect, it is known that some varieties are not or are difficultly self-fertile. Where this is known there is no necessity of emasculation. Emasculation is done the night before the morning the flower is expected to open, and then bagged, as usual. Pollination is done in the following day, and may be done from morning till noon, after which process the bag is restored for two or three days until the stigmas have wilted. It is advised by hibiscus breeders to use the stigmas and pollen when dry in crossing, otherwise, fertilization may not take place. In a few varieties, as the Nuuanu white of Hawaii, there is need of moistening the stigmas to allow the germination of the pollen.

Bud selection.—Various cases of bud variation in hibiscus have been reported by reliable persons. One case consists in a branch of a pink variety, producing white flowers. Another was a branch of a red variety producing pink flowers. In this College, several cases of bud variations, involving a change in leaf shape, have been observed on seedling varieties. A more common change is from broad or entire shape to that in which the leaves are deeply lobed and narrow. It is impossible to tell at present if these changes are mutations. The bud variations are produced invariably at the base of the plant. It is only to be expected that so big a change as these would be hereditary and their propagation will constitute a method of hibiscus breeding. An interesting hybrid was reported in Hawaii in which each twig was found different from any other.

Production and selection of new seedling varieties.—Hibiscus is more or less subject to natural crossing. Since it has been propagated almost exclusively by cuttings, it is only to be expected that there will be sufficient variability among seedlings to afford selection of new varieties. The work of producing seedling varieties in this College tends to support this supposition. By growing selfed seeds of one native variety, different seedling varieties have been produced. Variation is found either in the color and size of the flower, in the shape and size of the leaves, or in the habit of growth of the plant. In the light of these results growers of native hibiscus could produce new varieties of this plant if they could obtain seeds from their plants and grow them.

Some varieties produce many seeds while others produce only few seeds. A fruit may have from 5 to 30 seeds located in five chambers. It takes about a month for a fruit to mature from the flower stage. The seed is germinated like ordinary garden seeds. No special technique is required in germination. Seeds may germinate in 10 to 30 days.

The seedlings may be potted first before transplanting or may be transplanted direct to the garden.

Hibiscus seedlings began to flower in this College in from seven to nine months from the time the seeds were sown in seed boxes. These seedlings were

potted first before transplanting. It is believed that with better care, they would have flowered earlier. In Hawaii, the time required is from nine to twelve months.

PROPAGATION

By seed.—Unless it is desired to obtain new varieties of hibiscus, it is not advisable to propagate it by seed, although, as has been mentioned already, many varieties seed freely and the seeds have been used to produce hibiscus plants. To perpetuate varietal characters, propagation should be by vegetative means.

By cuttings.—This is the only method used generally in the Philippines. It is said that the best cutting to use is from wood one and one-half centimeters in diameter and fairly well matured. The tendency in the Philippines has been to use wood of smaller diameter. It is advised to make the cuttings about fifteen centimeters long and to root them in sand about one decimeter deep. If it is necessary to handle hundreds of cuttings, these may be tied in bundles of 100 for convenience. Cuttings prepared and planted in sand properly root in about a month. The rooted cuttings are transplanted, either into pots or into the garden. After rooting and transplanting, cuttings may flower in about six months.

By grafting.—This method is not at present adapted to common use by the ordinary person, but it is the quickest method in obtaining flowers from desirable plants.

Compared with budding, grafting is more desirable in that it gives a more symmetrical and profuse branching. Grafted scions bear flowers in about six months.

By budding.—Hibiscus may also be budded.

Results of hibiscus breeding in Hawaii.—In Hawaii, a number of new varieties have been produced by hybridization. These are described by Wilcox and Holt in a bulletin already referred to. A number of colored illustrations of old and new hybrid varieties were published in that bulletin and in an issue of the Mid-Pacific Magazine (**13:** (No. 2), February, 1917).

New varieties produced in the College of Agriculture.—Some one hundred new varieties of ornamental hibiscus have been produced in the College of Agriculture both by hybridization and selfing. Most of these are in the first seedling generation while a number are already in the second generation. These varieties have already flowered and among them various degrees of pink, red, white, yellow and salmon are represented. Several of them have produced bud modifications consisting of branches of different shaped leaves at the base of the stem. Requests for cuttings of some of the most beautiful seedling varieties have been received from several sources. At the request of the Bureau of Agriculture, cuttings of several desirable varieties were sent to several of its experiment stations from which it is expected that these new varieties will gradually find their way into the Philippine ornamental gardens and yards. Several private individuals who have seen these varieties in the Plant Breeding Nursery have also obtained several cuttings of such varieties as have pleased their eyes. Among such individuals are two from Pila, Laguna, who very kindly gave the Division cuttings of their varieties which are not found in the Division's collection.

At about the age of two years, these College hibiscus seedlings were studied with a view to determining their suitability as a Philippine ornamental and va-

rious adaptabilities as such. These seedlings were allowed to grow up to the time this study was made without pruning inasmuch as in the Philippines ornamental hibiscus is, and will be for some time to come, grown without pruning, and it was thought more proper to study these new varieties under conditions in which they are expected to be grown. Undoubtedly it will be necessary also, as a provision for special uses, to study subsequently how these varieties will respond to pruning.

Three characteristics are of outstanding importance in their adaptability as ornamentals. These are the height, the branching habit, and the appearance of the flower.

Regarding height, these seedlings may be grouped into tall, medium, and dwarf. (Plate I.) The first two groups are quite adapted for ornamental hedges and for individual plants behind fences. Possessing th height that they have, they could peep over the fences which are common in the native yards and thus could be exposed to the gaze of passers-by. The dwarf varieties are adopted for pot ornamentals. This type is something new in Philippine hibiscus growing as the old varieties are of the tall group. The result of an observation on a number of F_2 seedlings would tend to indicate that dwarfness is a recessive character.

In branching habit, the varieties vary from that type in which the branches are almost parallel to the main stem to that in which the branches are at right angles. In between these two types, are various forms in which the branches are spreading or drooping or lie in both and other positions. (Plate I.) The number of branches varies from practically none in those types which exhibit whip-like growth to numerous. It is very likely that non-branching habit is a recessive character.

The flower as well as other characteristics of the different varieties may be learned from the following descriptions. The seedlings are grouped as to parentage. By observing the variability existing among the offspring of each parent and whether the seeds from which these seedlings were artificial hybrids or not, an insight may be obtained as to the purity or homozygosity of the parent and as to what variability may be expected in similar work. It should be mentioned that for purposes of Mendelian study of heredity in hibiscus, the hybrids obtained in this work and described below are not suitable materials for study inasmuch as their parents are of unknown purity. In color descriptions, Ridgway's (3) book was used as reference.

PARENT: PINK. SEEDLINGS:

PINK-1.

Plant 85.0 cm high, branches lightly, not vigorous; leaves rough, round ovate, 3.5 cm. x 4 2 cm, with 0.9 cm. petiole, corolla 10.0 cm. wide, petals narrow, recurving, one-half of each petal shrimp pink, one half rose shade; staminal column, 5.0 cm long, white; stigmas scarlet; anthers yellowish; corolla throat at a diameter of 2.0 cm. distinct white, bracts 6, small, regularly set; susceptible to insect attack.

Pink-2 and Pink-3 are similar to Pink-1 in flower form and coloration, except that the former have their stigmas orange in color.

PINK-12.

Plant 70.0 cm. high, does not branch, exhibiting whip-growth habit, fairly vigorous, leaves smooth, ovate to cordate, 6.0 cm x 7.3 cm with 2 5 cm. petiole; corolla 10 0 cm. wide, petals straight, mustard yellow, base of petals with brownish red streaks; staminal column 7.2 cm. long, yellow; stigmas scarlet; anthers yellow; bracts 8, small and spreading.

PINK-14

Plant 74.0 cm. high, branches moderately, fairly vigorous; leaves rough, ovate to cordate in shape, 6.5 cm. x 4.2 cm with 3 0 cm. petiole; corolla 6.5 cm. wide, gray-violet with pink tinge; staminal column 3.8 cm. long, whitish; stigmas red; anthers yellowish brown; eye lined with pink; bracts 7, spreading; seeding freely.

PINK-16.

Plant 63.0 cm. high, branches little, fairly vigorous; leaves fairly rough, elliptical, 2.2 cm x 4 0 cm., with 2 0 cm. petiole; corolla 11.3 cm. wide, whitish pink; staminal column 4 5 cm. long, whitish yellow; stigmas scarlet red, anthers scarlet red; eye white, base of petal with pink rays; bracts 6, spreading.

PINK-17.

Plant 90.0 cm. high, branches profusely, fairly vigorous; leaves rough, ovate, 4 5 cm. x 6.5 cm. with 4 0 cm. petiole; corolla 11.5 cm. wide, corinthian pink with pink rays; staminal column 6 2 cm long, white; stigmas orange chrome; anthers light orange yellow; eye with pink rays; bracts 7, spreading; self seeding

Seedlings similar to Pink-17 in flower characteristics are Pink-13, Pink-15 and 24 Pink 12396-104.

PINK-18.

Flower characteristics very similar to Unknown-11.

PARENTS: DEEP PINK x BROWN. SEEDLINGS:

(DEEP PINK x BROWN) F_1-1.

Plant 150.0 cm. high, branches profusely, medium in vigour; leaves smooth, ovate to cordate, 4 0 cm x 6 5 cm. with 2.0 cm petiole; corolla 11 0 cm. wide, petals flat, pale pink with rose veins; staminal column 4 5 cm long, yellowish, stigmas scarlet red, anthers yellow, corolla throat at a diameter of 2 5 cm. white; bracts 8, long and spreading Susceptible to insect attacks

(DEEP PINK x BROWN) F_1-2

Plant 145.0 cm high, branches moderately, vigorous, leaves rough, ovate to cordate, 3 5 cm. x 6 0 cm with 1 5 cm petiole, corolla 11 5 cm. wide, petals recurved, salmon orange with orange yellow streaks, one-half of back orange yellow; staminal column 6 0 cm. long, orange yellow; stigmas scarlet red, anthers light salmon orange, eye 2 2 cm wide, light orange yellow, bracts 8, long loosely spreading, self-seeding to a little extent.

(DEEP PINK x BROWN) F_1-3.

Plant 200 0 cm high, branches lightly, obliquely, vigorous, leaves rough, ovate, serrated, 4 5 cm x 6 2 cm with 1 7 cm petiole, corolla 13 0 cm wide, light pink with distinct veins, staminal column 8 5 cm long, yellowish white, stigmas orange, anthers yellow, eye 2 0 cm diameter, white, bracts 8, long, spreading

(DEEP PINK x BROWN) F_1-4

Plant 120 0 cm high, branches moderately, close habit of branching, fairly vigorous, leaves rough, ovate to cordate, 4 5 cm x 7 0 cm with 2 5 cm petiole; corolla 12 5 cm wide, petals slightly recurving, white, edge of base of petals pink, staminal column 6 5 cm long, white, stigmas orange chrome, anthers brownish, throat of corolla white with pink rays, bracts 8

(DEEP PINK x BROWN) F_1-5

Plant 150 0 cm high, branches lightly, vigorous, leaves rough, ovate, 6 5 cm x 4 2 cm with 1 5 cm petiole; corolla 12 5 cm wide, white, staminal column 8 0 cm long, yellowish white, stigmas orange, anthers yellow, bracts 9, spreading; blooms in the afternoon

(DEEP PINK x BROWN) F_1-6

Plant 140 cm high, branches fairly, very vigorous, leaves rough, ovate 5 cm x 6 5 cm with 1 8 cm petiole, corolla 10 5 cm. wide; petals slightly recurving, scarlet with light orange yellow veins; staminal column 6 0 cm yellowish brown, stigmas scarlet; anthers brownish; corolla throat at diameter of 2 2 cm pale brownish shade, bracts 8, regularly and closely set One-half back of corolla, cadmium yellow badged. Flowers at long intervals of time.

(DEEP PINK x BROWN) F_1-7

Similar to (Deep Pink x Brown) F_1-3

(DEEP PINK x BROWN) F_1-8

Plant 89 0 cm high, branches moderately, fairly vigorous, leaves rather rough, ovate, 5 5 cm x 6 5 cm with 3 0 cm petiole; corolla 9.0 cm wide, daphne pink with white veins; staminal column 4 8 cm long, pale pink, stigmas scarlet red; anthers yellow; bracts 9, closely arranged

(DEEP PINK x BROWN) F_1-9.

Plant somewhat dwarfish, 80 0 cm high branches moderately, fairly vigorous, leaves rough, ovate to cordate, 4 0 cm x 6 0 cm. with 1 8 cm petiole; corolla 10.5 cm wide, petals flat, eosine pink with pale violet shade; staminal column 5 0 cm long, rose; stigmas carmine, anthers yellowish, base of petals deep pink, bracts 8, spreading Blooms at rather long intervals of time.

(DEEP PINK x BROWN) F_1-10.

Plant 105.0 cm high, branches sparsely, fairly vigorous; leaves rough, ovate, 5 0 cm x 7 5 cm. with 3 5 cm. petiole; corolla 10 4 cm. wide salmon orange with yellow linings; staminal column 6 5 cm long, orange-yellow, stigmas scarlet red; anthers pale orange yellow, eye 2.0 cm. diameter, carmine, bracts 8, long, spreading

PARENTS: NATIVE RED x HAWAIIAN SALMON. SEEDLINGS:

(NATIVE RED x HAWAIIAN SALMON) F_1-1.

Plant 210.0 cm. high, branches very profusely, very vigorous; leaves somewhat rough, ovate to cordate, 4 0 cm. x 5.2 cm with 1.3 cm. petiole; corolla 10.0 cm. wide, solid rose red; staminal column 7 0 cm long, red; stigmas scarlet; anthers brownish; eye, carmine; bracts 8, broad, close to peduncle; susceptible to insect attack

(NATIVE RED x HAWAIIAN SALMON) F_1-2.

Plant 190 0 cm. high, branches profusely, vigorous, leaves rather rough, ovate to elliptical, 7 0 cm x 4 5 cm. with 2.0 cm. petiole; corolla 11.0 cm. wide, flat, slightly recurving, rosy with eosine pink veins; staminal column 6.0 cm. long, pale yellow with carmine base; stigmas scarlet red; anthers pink; eye 3 0 cm diameter, carmine; bracts 8, short, spreading.

(NATIVE RED x HAWAIIAN SALMON) F_1-4

Plant 90.0 cm high, branches moderately, fairly vigorous, leaves rough, cordate, 4.0 cm x 4.7 cm with 1.5 cm. petiole; corolla 10.3 cm long, salmon orange with one-half of back maize-yellow, staminal column 5.8 cm. long, rose pink, stigmas carmine, anthers yellow, eye 3.0 cm. diameter, persian lilac; bracts 9, irregularly but closely set. Seeding freely.

PARENTS: HAWAIIAN SALMON x NATIVE RED. SEEDLING:

(HAWAIIAN SALMON x NATIVE RED) F_1-1

Plant 200.0 cm high, branches almost in a horizontal position, vigorous; leaves smooth, ovate, others three-parted, 2.5 cm x 6.0 cm. with 1.3 cm petiole, corolla 11.5 cm wide, petals narrow, recurving, whitish pink with pale violet shade, staminal column 5.5 cm long, pale pink, stigmas scarlet red, anthers brownish, eye carmine; bracts 6, long, spreading. Flowers open in the afternoon.

PARENTS: HAWAIIAN PINK x HAWAIIAN SALMON. SEEDLINGS:

(HAWAIIAN PINK x HAWAIIAN SALMON) F_1-3

Plant 58.0 cm high, branches moderately, fairly vigorous; leaves somewhat rough, ovate, 6.0 cm x 8.0 cm. with 3.4 cm petiole, corolla 7.5 cm wide, red salmon with yellow linings, staminal column 5.4 cm long, yellowish brown, stigmas orange, anthers pale yellow, throat of corolla with yellow rays, bracts 6, straight, adhering; does not seed freely.

(HAWAIIAN PINK x HAWAIIAN SALMON) F_1-4

Plant 123.0 cm high, branches fairly, vigorous leaves rough, ovate to cordate, 4.0 cm x 5.5 cm with 2.0 cm. petiole; corolla 11.5 cm wide, deep pink with white veins, staminal column 6.3 cm, whitish, stigmas crimson; anthers yellowish, base of petals at a diameter of 2.0 cm, distinct white, bracts 7, long regularly set. Seeding very freely.

PARENT: PINK 12396-104. SEEDLINGS:

11 PINK 12396-104

Plant 80.0 cm high, branches lightly, fairly vigorous, leaves rough, elliptical-ovate, 2.5 cm x 4.0 cm with 1.2 cm petiole, corolla 7.0 cm wide, light rose with pink veins; staminal column 5.0 cm long, yellowish, stigmas crimson, anthers yellow, bracts 8, long, closely set.

13 PINK 12396-104

Plant 100.0 cm high, branches moderately, fairly vigorous; leaves smooth, elongated-ovate, 3.5 cm x 6.0 cm with 3.0 cm petiole, corolla 8.0 cm wide, rose with pink rays, one-half of back yellow; staminal column 6.0 cm. long, yellowish, stigmas crimson, anthers yellow, eye 1.5 cm. diameter, with throat of corolla, white, very susceptible to insect attacks.

17 PINK 12396-104

Plant 72.0 cm high, branching moderately, fairly vigorous, leaves elliptical ovate 3.4 cm x 5.5 cm with 2.5 cm petiole, corolla 11.5 cm wide, eosine pink with white veins, staminal column, 4.5 cm long, yellowish white, stigmas scarlet, anthers yellowish, corolla throat at diameter of 2.0 cm pink and white mixed, bracts 6, long, spreading. Somewhat free seeding.

19 Pink 12396-104

Plant 118.0 cm high, branches moderately, fairly vigorous, leaves rather smooth, round ovate, 4.5 cm x 6.1 cm with 2.5 cm petiole, corolla 9.0 cm wide, light orange yellow with reddish veins, staminal column 5.5 cm. long, yellowish, stigmas scarlet red, anthers brownish, corolla throat at a diameter of 1.8 cm. deep chrome shade; bracts 7, regularly set; flowers open at rather long intervals of time.

20 PINK 12396-104

Plant 60.0 cm high, branches moderately, fairly vigorous; leaves rough, roundish ovate to cordate, 3.8 cm. x 5.2 cm with 1.1 cm petiole, corolla 9.2 cm wide, gray violet with pink rays, one half of back yellowish, petals straight, staminal column 6.5 cm long, whitish, stigmas orange red, anthers yellowish brown, base of petals with pink streaks; bracts 7, short, spreading.

21 PINK 12396-104

Plant 66.0 cm high, branches moderately, fairly vigorous, leaves fairly smooth, oblong-ovate, 6.5 cm. x 3.5 cm with 2.5 cm petiole, corolla 10.5 cm wide, petals recurving, pale pink with pink linings, one-half of back of corolla white; staminal column 4.5 cm long, whitish, stigmas reddish yellow, anthers pale yellow, base of petals pink, bracts 6, spreading, not self-seeding.

22 PINK 12396-104

Plant 60.0 cm high, branches moderately, fairly vigorous, leaves smooth, ovate, 4.2 cm x 6.0 cm. with 1.8 cm. petiole, corolla 9.2 cm wide, light violet pink with one-half of back yellowish, with pink linings, staminal column 5.0 cm long, whitish yellow, stigmas scarlet, anthers yellow, eye 1.4 cm. diameter, white; bracts 7, short, spreading, seeds freely.

23 PINK 12396-104.

Plant 90.0 cm. high, branches very lightly, fairly vigorous, leaves smooth, elliptical ovate 3.5 cm. x 5.5 cm. with 2.0 cm. petiole. Corolla 9.0 cm. wide, La France pink with white veins; staminal column 4.8 cm. long, whitish; stigmas scarlet, anthers yellowish; corolla throat at diameter of 2.0 cm. white; bracts 8, irregularly placed, spreading. Leaves very few, confined to tip of branches.

24 PINK 12396-104

Very similar in flower characteristics to Pink-17.

PARENTS: YELLOW x PINK. SEEDLING:

(YELLOW x PINK) F_1-1

Plant 110.0 cm. high, branches moderately, fairly vigorous, leaves smooth, ovate, 2 5 cm x 5.6 cm. with 1 0 cm. petiole, corolla 9.5 cm wide, pink, edge of base of petals white, one-half of back of corolla white, staminal column 5 5 cm. long, light purple; stigmas scarlet red, anthers pink; bracts 6, spreading.

PARENTS: PINK x ARAÑA. SEEDLING:

(PINK x ARAÑA) F_1-4

Plant 131 0 cm high, branches moderately, vigorous; leaves smooth, elliptical ovate, 4.0 cm x 5 2 cm with 1.5 cm petiole; corolla 10 0 cm wide, one-half of back yellow, petals slightly recurving, rose pink with rose veins, staminal column 5 0 cm long, whitish; stigmas scarlet, anthers yellowish, corolla throat at diameter 1 8 cm white, bracts 7, regularly placed.

PARENTS: ARAÑA x PINK SEEDLINGS:

(ARAÑA x PINK) F_1-1.

Plant 98 0 cm high, non-branching, fairly vigorous, leaves smooth, round ovate, 3 5 cm x 4 8 cm with 1 2 cm petiole, corolla 11 0 cm wide, petals slightly recurving, flame scarlet with light salmon-orange veins, staminal column 5 5 cm long, yellow, stigmas, scarlet red, anthers yellow, eye at a diameter of 2 0 cm yellow and red rays; bracts 8, medium, regularly placed

(ARAÑA x PINK) F_1-3.

Plant 115 0 cm high, branches moderately, twigs in horizontal position, fairly vigorous, leaves smooth, round-ovate, 6 0 cm. x 6 7 cm with 2 5 cm petiole, corolla 10 5 cm wide, deep rose pink with white veins, staminal column 5 5 cm long, yellowish pink, flower throat with some pink rays, bracts, 8, regularly set Seeding freely

Seedlings similar to this in flower are (Ping x Araña) F_1-1 and (Pink x Araña) F_1-3.

PARENTS: HAWAIIAN PINK x NATIVE RED. SEEDLINGS.

(HAWAIIAN PINK x NATIVE RED) F_1-1

Plant 208 0 cm high, branches very heavily, very vigorous, leaves rough, ovate, others three-parted, 3 5 cm. x 6 2 cm with 1 0 cm petiole, corolla 12 5 cm wide, petals slightly recurving, staminal column 7 0 cm long, pink, stigmas, carmine, anthers brownish, eye carmine, with a diameter of 3 0 cm , bracts 7, regularly placed, one-half of back of corolla white, seeds freely

(HAWAIIAN PINK x NATIVE RED) F_1-2

Plant 214 0 cm high, branches lie horizontally, very vigorous, leaves smooth, ovate, others three-parted, 4 0 cm x 5 5 cm with 1 4 cm petiole, corolla 11 0 cm wide, one-half of back white, petals narrow, straight, cosine pink with begonia rose veins, staminal column 6 0 cm long, pale pink, stigmas carmine, anthers brownish, eye scarlet, 1 5 cm diameter, bracts 6, spreading, seeding freely

PARENT: UNKNOWN SEEDLINGS:

UNKNOWN-1

Plant 140 0 cm high, branches moderately, branches closely arranged, vigorous, leaves smooth, ovate to elliptical, 4 8 cm x 6 0 cm with 1 5 cm petiole, corolla 11 0 cm. wide, flat, slightly recurving, begonia rose with reddish rays and veins with one-half of back maize yellow, staminal column 4 5 cm long, rose; stigmas scarlet red, anthers pink, eye, 2.0 cm diameter, scarlet, bracts 7, long, spreading Seeding very freely

UNKNOWN-3

Plant 160 0 cm high, branches profusely, very vigorous, leaves smooth, cordate to ovate, 5 0 cm x 7 2 cm with 3.2 cm petiole, corolla 11 0 cm wide, petals recurving, Rosolane pink with thulite pink veins, staminal column 6 0 cm. long, white, stigmas deep red; anthers yellow with pink filament, eye 2 5 cm diameter, crimson, bracts 7, closely set, flower bud pink. Naturally self-seeding

UNKNOWN-4.

Same as Unknown-3

UNKNOWN-6.

Plant 200 0 cm high, branches heavily, very vigorous; leaves smooth, cordate, three-parted, 6 0 cm x 9 5 cm. with 5 0 cm. petiole; corolla 8.0 cm wide, solid pink; staminal column 6.5 cm long, pink - stigmas crimson red, bracts 7, long, spreading, petals do not spread evenly.

UNKNOWN-7.

Plant 100.0 cm. high, branches heavily, very vigorous; leaves smooth, ovate to cordate, serrated, 7 5 cm x 11.5 cm with 6 0 cm petiole, corolla 13 0 cm. wide, petals recurving, pink with dark pink veins, and one-half of back of corolla white; staminal column 7.0 cm. long, pink red, stigmas crimson red; anthers yellow, filament red eye 4.0 cm. diameter, crimson red; bracts 8, closely set; naturally self-seeding Other Unknown seedlings very much like Unknown-7 are: Unknown-2 (except this has narrower corolla). Unknown-5 is very similar to Unknown-7 in flower characteristics.

UNKNOWN-8.

Plant 98.0 cm. high, branches profusely, fairly vigorous; leaves somewhat smooth, ovate, 5 5 cm x 7 8 cm with 2 5 cm petiole; corolla 12 0 cm. wide, petals somewhat recurving, pink with white veins, staminal column 6.2 cm. long, whitish yellow; stigmas crimson red; anthers yellowish brown; throat of corolla 3 0 cm. diameter, white; bracts 7, spreading, irregularly set; naturally self-seeding.

UNKNOWN-10.

Plant 158.0 cm. high, branches moderately fairly vigorous; leaves, rough, elongated-ovate, 4.0 cm. x 7.5 cm. with 2.5 cm. petiole; corolla 9 5 cm. wide, Begonia rose, distinct white veins one-half of back blotched white; staminal column 7.5 cm. long, yellowish; stigmas, scarlet; base of petals, with crimson veins at edge; bracts 6, regularly set

UNKNOWN-11.

Plant 114.0 cm. high; branches moderately, vigorous; leaves smooth; ovate to cordate, 4.7 cm. x 5.6 cm with 1.2 cm petiole; corolla 7.0 cm. wide, cadmium orange with distinct yellow veins; staminal column 4 4 cm. long, yellowish, stigmas scarlet; anthers brownish; corolla throat at 1 8 cm. diameter light orange yellow; bracts 7, long, close to peduncle. Susceptible to insect attack.

UNKNOWN-12.

Plant dwarfish, 14 0 cm high, branches heavily, vigorous, leaves smooth, cordate, 5.1 cm. x 7 2 cm. with 1.3 cm petiole; corolla 10 5 cm. wide, petals slightly recurving, solid nopal red, with one-half of back of corolla salmon orange, staminal column 5 2 cm long, pale scarlet; stigmas carmine, anthers carmine, bracts 8, spreading, medium in length.

PARENT: NATIVE RED. SEEDLING:

NATIVE RED-1

Plant 140 0 cm high, branches profusely, vigorous; leaves smooth, elongated-ovate, three parted; with 1.5 cm petiole, corolla 12 0 cm. wide, deep pink, one-half of back white, petals narrow; staminal column 7 0 cm long, pink, stigmas scarlet red; anthers pink-red, eye dark crimson; bracts, 7, long, spreading.

IMPORTANT INSECT ENEMIES

Two important enemies of the seedling hibiscus reported in this paper have been discovered. These are as identified by the Entomology Department of the College of Agriculture the insects *Phenacoccus hirsutus* Green, belonging to the family Coccidae, and two species of *Nisotra*,—*Nisotra gemella* Erichs. and *Nisotra* sp. which belong to the family Chrysomelidae. These insects eat the flower buds, the open petals and the tender leaves of the plant. It is not known that the native varieties are attacked by these enemies, and some of the seedling varieties are fairly resistant to them. Wilcox and Holt made no mention of these particular pests in their work. It is very probable that these insects have contributed very largely to the causes of the failures of many of the introduced ornamental hibiscus in this College, and, in the future, are a factor to contend with in further introduction. Mr. Feliciano Reveche who made some studies of the pests declares that *Phenacoccus hirsutus* could be controlled with kerosene emulsion spray in which the constituents are in the proportion of 7.5 liters kerosene, one-fourth kilogram hard soap and 4 liters of water. Other insects were observed, some of them feeding on the leaves, but they are comparatively not serious to the growth of the plant, although the holes which are produced in the leaves give these an ugly appearance at times.

ACKNOWLEDGEMENT

The authors are greatly indebted to Mr. Juan Unite, also of the Genetics Division of the Agronomy Department, for taking care of most of the hibiscus cultures involved in this study and his contribution in the information on the different seedling varieties, and to Plant Breeding students of the year 1920-21.

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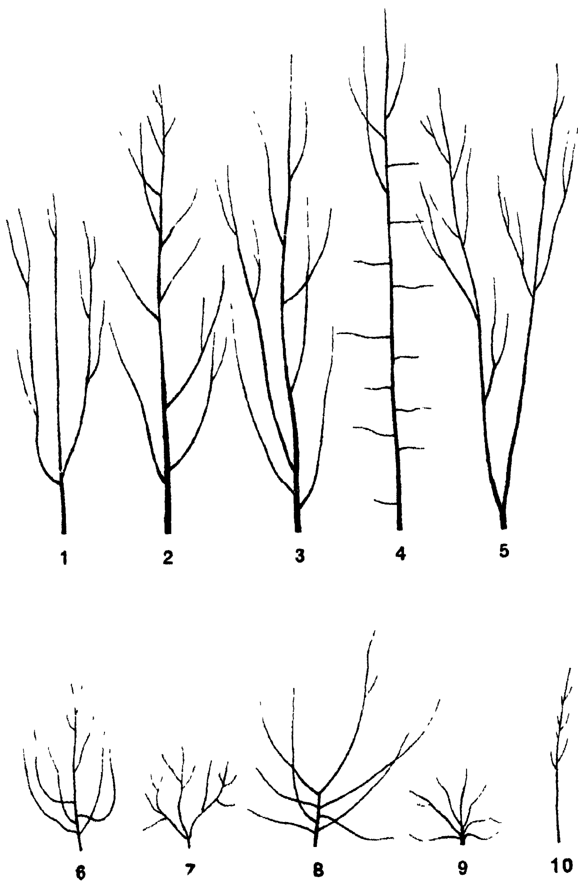

Plate I

Height types of seedlings.
Branching types of seedlings.

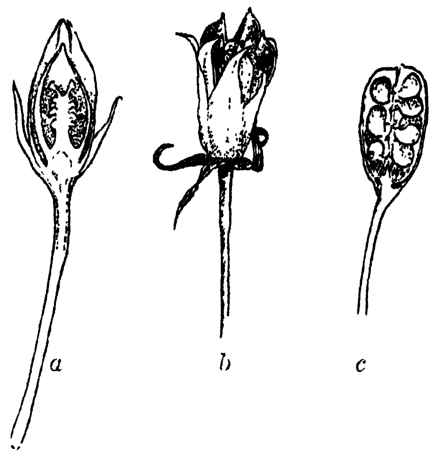

Figure 1

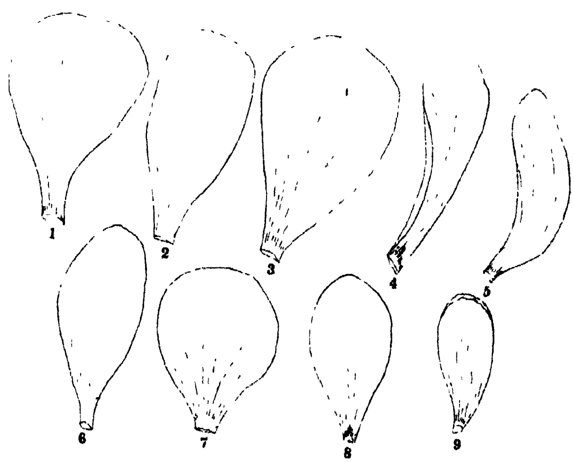

Figure 2

Plate II

FIGURE 1 (*a*) Flower bud of Gomamela, longitudinal section. (*b*) Gomamela fruit, bursting. (*c*) Longitudinal section of matured fruit, showing seed attachment.

FIGURE 2 Different shapes of petals (single corolla) as shown by the seedlings reported here.

ADDITIONAL CYANOPHORIC PLANTS OF THE MAKILING REGION[1]

By J. B. JULIANO

Of the Department of Plant Physiology

The list of plants herewith presented is by no means a thorough study of all cyanophoric plants in this locality but is rather an addition to what had already been drawn up by Professor D. A. Herbert of the Department of Plant Physiology. Only grasses, weeds, as well as some ornamental and food plants were dealt with. The second modified Guignard test was employed and consisted in "the immersion of the material in sodium picrate solution to which a little chloroform had been added". Most of these tests were carried by the second year Veterinary students working under the supervision on a course of Veterinary Botany at the College of Agriculture during the month of January, 1923, of the second semester of the school year 1922-23. Some results of tests have not been included so as to avoid duplication, but all of them confirmed the findings just recently reported. However, some plants which gave negative reactions before show faint traces of prussic acid. This may be due to differences in time of the determinations and the attendant conditions surrounding the plants studied.

AMARANTHACEAE

Amaranthus viridis (Colites): Trace in root, stem, and leaves.

ARACEAE

Colocasia esculentum (Gabi): Slightly positive in root, stem, and leaves.
Xanthosoma sagittifolia: Slightly positive in tuber, leaves and petioles.

CANNACEAE

Canna speciosa: Positive in leaves, slightly positive in stem and roots.

CARICACEAE

Carica papaya (Young papaya): Slightly positive in stem and roots.

COMMELINACEAE

Commelina benghalensis (Alicbangon): Negative in root and leaf, trace in stem.

COMPOSITAE

Synedrella nodiflora: Negative in leaf, trace in roots and stems.

CYPERACEAE

Cyperus distans: Positive in root, slightly positive in stems and leaves.

CRUCIFERAE

Brassica oleracea (Cabbage): Trace in root, stem, and leaves.

[1] Experiment Station Contribution No. 111.

EUPHORBIACEAE

Euphorbia hirta: Positive in roots, trace in stem and leaves.

Manihot utilissima (Manioc, Camoteng Kahoy): Positive in root and leaves, slightly positive in stem.

GRAMINEAE

Andropogon sorghum (Sorghum, Batad): Slightly positive in roots, stems and leaves.

Andropogon halapensis (Batad-bataran): Positive in roots, slightly positive in stems and leaves.

Bambusa blumeana (Cauayan totoo):. Trace in roots.

Panicum flavidum: Trace in root and leaves.

Paspalum conjugatum (Calupe): Positive in root, trace in stem and leaves.

LABIATAE

Leucas lavandulifolia: Positive in roots, stems, leaves, and trace in flowers.

LEGUMINOSAE

Arachis hypogea (Mani): Positive in roots, trace in stem; negative in leaves.

Canavalia ensiformis (Sword bean): Trace in roots and leaves; negative in stem.

Indigofera suffruticosa: Trace in roots, stems, leaves and fruit.

Phaseolus radiatus (Mongo): Slightly positive in roots, leaves and fruits; negative in stem.

Pisum sativum (Pea, Chicharo): Trace in root, stem, leaves and fruits.

Tephrosia candida: Trace in roots, stem, leaves and flowers.

MALVACEAE

Corchorus capsularis (Pasaó): Slightly positive in leaves, stems, roots and fruits.

MARANTACEAE

Marantus arundinacea (Sagó): Slightly positive in roots and leaves.

MYRTACEAE

Psidium guajava (Guava, bayabas): Trace in root, stem, leaves, and fruits.

OXALIDACEAE

Averrhoa bilimbi (Camias): Slightly positive in roots, stems, leaves; negative in fruit.

PORTULACACEAE

Portulaca oleracea (Golasiman): Slightly positive in roots, stems, leaves and fruits.

POLYGONACEAE

Polygonum barbatum: Slightly positive in roots, leaves, and stems.

URTICACEAE

Boehmeria nivea (China grass, Ramie): Slightly positive in root, stem and leaves.

COLLEGE AND ALUMNI NOTES

B. M. Gonzalez, '13, completed his work for the degree of Doctor of Science in November, 1922, in Johns Hopkins University. The topic of his dissertation, presented to the faculty of the School of Hygiene in Johns Hopkins University, is "The Chromosomal Localization of Five Factors Determining Duration of Life in Drosophila melanogaster". He is now travelling, with his family, in Europe, and expects to be back before classes open here in June.

Sotero F. Albano, '13, is with the Bureau of Agriculture as Fiber Inspector for the Ilocos provinces. His business address is at Vigan, Ilocos Sur. Mr. Albano was formerly an assistant in the Department of Mathematics and later in the Department of Agronomy of this College.

Gregorio Grageda, '16, is supervising teacher for Sigaboy District in Davao. He was formerly the Technical Agricultural Assistant for Sulu. This office was later abolished causing his transfer to Davao.

Domingo B. Paguirigan, '16, who was a pensionado of the Bureau of Agriculture, obtained the degree of Master of Science from Connecticut Agricultural College in 1920. He was employed in the Connecticut Agricultural Experiment Station at New Haven during the summer of 1920, and attended the Bussey Institution during the year 1920-1921. He is at present with the Bureau of Agriculture, in charge of the tobacco work of the Bureau. He is stationed mostly at the Dammao Tobacco Station, Gamu, Isabela, and part of the time in Manila, and in Pikit, Cotabato, and possibly also, at the College of Agriculture.

Leoncio Dario, '19, has been with the Bureau of Agriculture since his graduation from the College. He is at present detailed in the Manila office working in the Agronomy Section of the Plant Industry Division.

Anastacio Limbo, '20, is Acting Industrial Supervisor of fifty-nine settlement farm schools in Bukidnon. His address is Malaybalay, Bukidnon.

Antonio Derecho, '20, is now Acting Supervising Agricultural Agent of the Bureau of Agriculture. He experienced that "travel even within our country adds a great deal to our education obtained in the College".

Atanacio T. Carandang, '20, is at present an assistant sugar cane investigator of the Pampanga Sugar Development Company. Mr. Carandang was formerly a graduate assistant in the Department of Agronomy in this College.

Maximo P. Canonizado, '20, is a supervising teacher of the Bureau of Education stationed in Pagsabañgan, Tagum, Davao. He is in charge of twelve settlement farm schools. He writes that he likes his job very well. He deals mostly with Moros, Mandayas, and Aetas.

Lieutenant Nemesio Catalan, '20, visited the College on December 17, 1922. Mr. and Mrs. Catalan were in Los Baños with their family on the occasion of the town fiesta held on December 16th. Mr. Catalan is now stationed in Fort McKinley, and he says that he is enjoying his work in the army.

Catalino S. Rayos, '22, is at present teaching in the Pangasinan High School. He intends to go to private farming as soon as he accumulates enough capital to start with.

Francisco Mendoza, '22, is now assistant in Sugar Cane Investigations for the Philippine Sugar Centrals Agency. He is at present stationed in Isabela, Negros Occidental.

Vito C. Rada, a former student of this College, addressed the College of Agriculture Alumni Association at its meeting held January 9, 1923. Mr. Rada talked about his experiences in his work with the Bureau of Education. He also dealt with the work of farm schools in their relation to the work of the College of Agriculture. Mr. Rada is now a teacher in the Batangas Farm School. He is planning to continue his studies here next June.

ERRATUM

THE HERPETOLOGICAL FAUNA OF MOUNT MAKILING

By Edward H. Taylor

A line was omitted in the last sentence of the addendum of the paper entitled "Herpetological Fauna of Mount Makiling" by Edward H. Taylor in the December issue (Philippine Agriculturist XI 5, page 139). The last line should read ". . . . . one lizard, *Gonyocephalus semperi* Peters and a small snake *Calamaria bitorques* Peters."

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A STUDY OF THE GROWTH OF THE HOOFS OF NATIVE HORSES[1]

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The following study was undertaken with the object of ascertaining the rate of growth of the normal and healthy hoofs of native (Filipino) horses, which might be of some interest both to practicing veterinarians and animal husbandmen. In searching the literature on the subject I was not able to find any previous work on the hoofs of native horses, and I noticed that the observations on the rate of growth of the hoofs of horses of foreign breed are not at all uniform.

It has long been recognized by many interested in animals that the ability of the horse to perform labor depends largely, if not wholly, upon his possession of four good, sound feet. The horse's feet, exposed as they are, to multiple injuries in the pasture as well as in the road, are not infrequently the most common seat of various diseases which cause lamness and affect the value of the animal. The veterinarians, when called upon to treat injuries or diseases of the hoof of horse's foot,—such as cracks, clefts, quittor, side-bone, keratoma, etc.,—that require cutting or removal of portions of horn tissue, are confronted with one simple but important question: How much time is necessary for the repair of the injured or removed horn tissue and to put the animal back into work? The answer to this question is also simple and requires only a little mental figuring. When one knows the rate of growth of the normal and healthy hoofs under normal condition, it is not a difficult matter to compute the length of time that would be required to repair the injured or diseased part.

Animal husbandmen, in buying horses for breeding purposes, always select those which possess the qualities and characters that they desire to be transmitted to the offspring, on the assumption that the good and bad points of the young are inherited from their parents. The applicability of the principle of heredity in breeding is beyond question, but at the same time one should not overlook the fact that there are certain defects of horse's foot, like for instance, contracted heels, clubfoot, crookedfoot, etc., that are acquired due to improper care of the hoof, especially during colthood. Conditions of this kind should not be attributed only to faulty trimming and paring of the hoofs but also to lack of knowledge on the part of the caretaker as regards the amount of horn tissue to be removed after a certain length of time.

[1] Experiment Station Contribution No. 112.

For this experiment ten selected horses were used, five of which were from the Animal Husbandry Department, College of Agriculture, and the rest from the "in-cases" in the Veterinary Hospital, College of Veterinary Science. The selection of the horses was based principally upon the soundness of the feet, age, sex, and general condition of the body.

Of the five horses from the College of Veterinary Science, two were suffering from epizootic lymphangitis, one from acute tendinitis in one of the posterior limbs, one from burn, and one from melanotic tumor. All these five animals, in spite of the maladies they were suffering from, were in fairly good body condition. The horses from the Animal Husbandry Department were all sound and healthy and used only for experimental and breeding purposes. Of these ten horses, five were stallions, one was a gelding, and four were mares. Only five were shod.

In determining the age of each animal from the College of Veterinary Science, careful and thorough examination of the teeth, which is one of our most potent methods of finding the age of our larger domestic animals, especially horses, was employed. The age of each animal from the Animal Husbandry Department was taken from the record of the department. The examination of the feet for soundness was based principally upon the obliquity of the wall of the hoofs, the presence and regularity of the striae, or horn fibers, and the presence of normal rings around the hoof wall.

The horses from the College of Veterinary Science, during the entire period of the experiment, were confined in the hospital and they were so kept that wetting their feet with water was avoided as much as possible. So the only possible supply of moisture of the hoofs was from the manure, urine, floor of the stall, and the air. On the contrary, the horses from the Animal Husbandry Department were tied early every morning with long rope in the pasture, under which condition their feet regularly got wet for a few hours every day. It is apparent, then, that the hoofs of the animals from the Animal Husbandry Department received more moisture than those of the animals from the College of Veterinary Science.

It is now generally accepted that the horn tubules and the intertubular substance which constitute the bulk of the wall of the hoof are produced by the proliferation of the cells,—corresponding to stratum germinativum or Malphigian layer of the epidermis,—which cover the papillae and interpapillary spaces of the coronary cushion, and that the growth of the wall is from above downward. This downgrowth of the wall is proven by the fact that if the hoof is marked with a rasp or file, it will be found after some time that the mark is receding from the coronary border and approaching the ground. So it is quite evident that in order to measure the hoof growth, the superior (fixed) point must be above the coronary cushion and the inferior (moveable) point below it. For the superior or fixed point, I used the line between the hair-bearing skin and the periople, that is, the line where the hair ceases to grow, and to make it more distinguishable and easier in taking the measurement I painted it with 40% aqueous solution of eosin. The inferior, or movable point was represented by a narrow transverse groove on the wall of the hoof, just a little below the level of the coronary groove. This transverse groove was made by means of a fine three-sided file, and deep enough to cut through the stratum tectorium

into the substance of the middle layer of the wall. It may be stated in this connection that in no instance was the groove made more than three millimeters in depth. The groove was made to run parallel to the coronary border and to its corresponding superior line. It was also painted with 40% aqueous solution of eosin. I might add here that the color of the eosin remained distinct during the entire period of the experiment, especially with the horses which were confined in the Veterinary Hospital.

Only one fore foot and one hind foot of each horse were used, and the toe, the quarters (medial and lateral), and the heels (medial and lateral) were marked according to the method described above. The distance between the superior line and its corresponding inferior groove was carefully taken and recorded as the "initial measurement".

The subsequent measurements were taken at seven-day intervals, and the method by which the measuring was done may be described as follows: By means of a fine pointed compass the distance between the corresponding points (superior and inferior) was taken, and then the distance between the two points of the compass was measured. Great care was observed so as to have the imaginary line connecting the points of the compass coincide with the direction of the striae of the hoof. The weekly measurement and weekly growth of the hoofs of each horse were recorded and computed according to the plan illustrated in Table I.

DISCUSSION OF RESULTS

According to Reeks (1) the growth of the hoof is favored by moisture, but in my observation, as may be noted in Table II, moisture apparently has no material influence upon the rate of growth of the hoof,—the average growth of the hoofs of the horses which had abundant supply of moisture being 9.32 millimeters per month and that of those having very limited supply of moisture 9.18 millimeters per month. If moisture hastens the growth of the hoof the heel must necessarily grow more rapidly than the quarters and the toe, because according to Smith (2) it contains more moisture than the other sections of the wall of the hoof, and if this is the case the assertion of Reeks and other investigators (3), (4), (5), that the wall of the hoof grows uniformly from the coronet, that is, the toe, the quarters, and the heels grow with equal rate, will no longer hold good. But in my experiment it was my observation that one section of the wall grows just as rapidly as another.

With reference to the connection of moisture with the growth of the hoof, in my opinion, excessive amount of it does not affect or alter the rate of hoof growth. Its presence, however, in the horn cells is absolutely indispensable for maintaining its normal growth, because insufficient quantity or lack of moisture renders the horn tissue dry, hard, and unyielding, under which condition the horn growth is hindered. As an explanation to this condition, the following may be suggested: The make-up of the hoof, if analyzed from the standpoint of its origin and morphology, is nothing more than superimposed layers of epithelial cells which have undergone keratinization. The cells forming the wall of the horn tubules are concentrically arranged around their lumen, while those lying between the tubules which constitute the intertubular substance present no definite arrangement. Since the horn tubules and intertubular substance which mainly make up the hoof, as before described, are produced by the proliferation of epithelial

cells which cover the outer surface of the corium of the foot, it is quite legitimate to state that the farther they are traced from the corium from which they arise, the older the horn cells become. Take the wall of the hoof, for instance, the younger cells are located near the coronary border while the older ones near the ground border. Now, if the horn tissue is hard and unyielding due to lack or insufficient quantity of moisture, the younger cells encounter great difficulty in pushing the older ones toward the periphery, as a consequence of which the horn growth is delayed. Furthermore, when the hoof is in a dry state its physiological movements, which have something to do in facilitating the local blood circulation, as will be alluded to in the latter part of this paper, are more or less interfered with.

My finding with reference to the influence of shoeing upon the growth of the hoof agrees more or less with those of Lungwitz (3) and Adams (4), in that unshod hoofs grow more rapidly than the shod. According to my experiment, as may be noted in Table III, the average monthly growth of shod hoofs is 9.03 millimeters, and that of unshod 9.41 millimeters. No attempt, as far as I was able to find, was made by these investigators to explain why the growth of the hoof is favored by the horse going barefooted.

The question is somewhat obscure when viewed from the anatomical standpoint, but if the effects of shoeing on the mechanism of the foot are taken into account, the following theory may be of some help for its elucidation: When the foot comes in contact with the ground the impact of the body-weight is immediately transmitted to its horny wall by the structures contained within the hoof, and in response thereto the wall of the latter dilates laterally both at the ground and coronary borders. Soon after the hoof is relieved of the pressure of the body-weight, it contracts and assumes its original form. The dilatations and contractions of the hoof, which are continually alternating even when the horse is at rest in standing position, produce a sort of a pumping action by which the venous circulation in the foot is largely facilitated. During the dilatation of the hoof the blood is being driven upward and the veins are emptied, and during contraction it is aspirated and the veins are filled. In that way the corium of the foot is insured of a lively blood circulation upon which the rapidity of growth of the horn mostly depends. Now, when the hoof is shod its physiological movements, dilatations and contractions, are more or less restricted or checked at the bearing margin, so that the force of the heart is left with a very little help, if there is any, in emptying the foot of its venous blood and in driving into it the arterial blood that contains the necessary nutritive materials for the horn growth.

Table IV shows the weekly growth of the wall of the hoofs of each individual animal. By comparing the weekly growth at the different sections around the wall of both the anterior and posterior hoofs of each horse, it will be noticed that there is no material difference regarding their rate of growth from the coronary border. The fractional difference that may be observed in some cases, I think, is only due to the fact that the fractions of a millimeter below five-tenths were omitted in recording the weekly measurements of the different sections. This shows that the wall of the hoof grows downward almost uniformly from the coronet, that is, the rate of growth at all sections,— the toe, the quarters, and the heels,—in the wall is almost regular. If such is the growth of the hoof, it is very natural to expect that the age of the horn cells at the bearing or ground border of the wall varies according as the toe, the quarters, or the heels are under

consideration. The toe being the highest section of the wall naturally posses-ses the oldest cells at its bearing border, and the heels being the shortest have the youngest.

Like the observations of the investigators cited elsewhere in this paper, I found that the posterior hoof grows faster than the anterior. The average monthly growth of the anterior hoof is 8.73 millimeters, whereas that of the posterior hoof is 9.76 millimeters. No explanation can at present be offered why the posterior hoof grows more rapidly than the anterior hoof.

If the average weekly growths of the hoofs of horses Nos. 7 and 9 which are the youngest of the horses used are compared with those of other horses, it will be observed that the age of animal has no apparent effect on the rate of growth of the hoof. Also it will be observed, if the growths of the hoofs of animals of both sexes and of different size and color are examined, that sex, size, and color have no relation at all to the rapidity of growth of the hoof. This observation regarding the relation of sex to the growth of the hoof is contrary to that of Adams who states that the hoofs of the mares grow more rapidly than those of the stallions.

Taking the average of growth at the different sections around the wall of the anterior and posterior hoofs of animals of both sexes and of different color and size, it gives an average growth of 9.25 millimeters per month. This rate is a little higher than what has been given by the following authors for horses of foreign breed:

Reeks (1)	¼″ or 6.35 millimeters per month.
Lungwitz (3)	5/16″ or 8 millimeters per month.
Adams (4), (5)	⅓″ or 8.46 millimeters per month.

If the average growth is 9.25 millimeters per month, the length of time required for the complete renewal of the hoof of native horses at any section varies according to the height of the toe, the quarters, and the heels. According to my own observation the height of the wall of the hoof of native horses is from 7 to 9 centimeters at the toe, 5 to 7 centimeters at the quarters, and 3 to 5 centimeters at the heels. So it is apparent that the time required for the horn to grow from the coronary border to the ground border of the wall is about 7 to 10 months at the toe, 5 to 8 months at the quarters, and 3 to 6 months at the heels.

SUMMARY OF CONCLUSIONS

1. The average growth of the hoof of native horses is 9.25 millimeters per month.
2. Excessive amount of moisture has no effect on the rate of growth, but what the hoof requires for maintaining its normal growth is that quantity of moisture just sufficient to keep its normal elasticity and yielding character.
3. Unshod hoofs grow somewhat faster than shod.
4. Posterior hoofs grow more rapidly than anterior.
5. The rate of growth of the wall of the hoof is almost regular around the coronet.
6. Apparently age, sex, color, and size of the animal have no connection with the rapidity of growth of the hoof.

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TABLE I.—*Record of Horse No. 1 illustrating the way [illegible] growth of the hoofs of each animal was recorded and computed.*

Date.		Anterior hoof.										Posterior hoof.									
				Lateral.				Medial.						Lateral.				Medial.			
				Quarter.		Heel.		Quarter.		Heel.				Quarter.		Heel.		Quarter.		Heel.	
		Toe	Weekly growth.		Weekly growth.		Weekly growth.		Weekly growth.		Weekly growth.	Toe.	Weekly growth.		Weekly growth.		Weekly growth.		Weekly growth.		Weekly growth.
		mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Mar. 17	Initial measurement.	25		22		23		25		26		26		27		25		27		25	
			2		2		2		2		2		3		3		2		3		1
Mar. 24		27		24		25		27		28		29		30		27		30		26	
			3		3		2		2		2		2		2		3		2		2
Mar. 31		30		27		27		29		30		31		32		30		32		28	
			2		2		2		2		2		3		3		2		3		2
April 7		32		29		29		31		32		34		35		32		35		30	
			3		2		3		2		2		1		2		3		2		3
April 14		35		31		32		33		34		35		37		35		37		33	
			2		2		3		2		2		2		2		2		2		2
April 21		37		33		35		35		36		37		39		37		39		35	
			3		2		2		2		2		2		2		2		3		2
April 28		40		35		37		37		38		39		41		39		42		37	
			2		2		2		2		2		3		3		3		3		3
May 5		42		37		39		39		40		42		44		42		45		40	
			3		2		3		2		2		2		2		3		2		2
May 12		45		39		42		41		42		44		46		45		47		42	
			2		3		2		3		2		3		3		2		2		3
May 19		47		42		44		44		44		47		49		47		49		45	
			2		2		2		2		2		2		3		3		3		3
May 26		49		44		46		46		46		49		52		50		52		48	
Total growth in ten wks.			24		22		23		21		20		23		25		25		25		23
Average per week.....			2.4		2.2		2.3		2.1		2		2.3		2.5		2.5		2.5		2.3

TABLE II.—*Showing the influence of moisture upon the growth of hoof.*

Horses kept without getting their feet wet.											Horses kept with their feet wet every morning.										
Horse No.	Anterior hoofs.					Posterior hoofs.					Horse No.	Anterior hoofs.					Posterior hoofs.				
	Toe.	Lateral.		Medial.		Toe.	Lateral.		Medial.			Toe.	Lateral.		Medial.		Toe.	Lateral.		Medial.	
		Quarter.	Heel.	Quarter.	Heel.		Quarter.	Heel.	Quarter.	Heel.			Quarter.	Heel.	Quarter.	Heel.		Quarter.	Heel.	Quarter.	Heel.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1	2.4	2.2	2.3	2.1	2	2.3	2.5	2.5	2.5	2.3	6	2.2	2.2	2.3	2.1	2.3	2.5	2.5	2.5	2.4	2.4
2	2	2.2	2.4	2.3	2.1	2.5	2.3	2.3	2	2.1	7	2.1	2.1	2.2	2.4	2.4	2.6	2.7	2.6	2.4	2.7
3	2.4	2.3	2.4	2.3	2.2	2.5	2.5	2.3	2.5	2.4	8	2.2	2	2.1	2.3	2.2	2.5	2.6	2.5	2.5	2.7
4	2.3	2.4	2.3	2.2	2.2	2.5	2.4	2.4	2.4	2.4	9	2.1	2.2	2	2	2	2.5	2.4	2.5	2.4	2.4
5	2.2	2.1	2.1	2	2.1	2.4	2.5	2.1	2.2	2.5	10	2.2	2	2	2	2	2.5	2.6	2.6	2.3	2.5
Average	2.26	2.24	2.30	2.18	2.12	2.44	2.44	2.32	2.32	2.34	Average	2.16	2.12	2.1	2.18	2.18	2.52	2.58	2.54	2.4	2.54

a. Average monthly growth of hoofs with limited supply of moisture = 9 18 mm.
b. Average monthly growth of hoofs with plenty of supply of moisture = 9 32 mm.

TABLE III.—*Showing the influence of shoeing upon the growth of hoof.*

Horses with shod hoofs.

Horse No.	Anterior hoofs.					Posterior hoofs.				
	Toe.	Lateral.		Medial.		Toe.	Lateral.		Medial.	
		Quarter.	Heel.	Quarter.	Heel.		Quarter.	Heel.	Quarter.	Heel.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1	2.4	2.2	2.3	2 1	2	2 3	2 5	2.5	2.5	2.3
2	2	2 2	2.4	2.3	2.1	2 5	2 3	2 3	2	2.1
5	2.2	2.1	2 1	2	2.1	2 4	2 5	2.1	2 2	2 5
6	2.2	2.2	2.3	2.1	2.3	2.5	2 5	2.5	2 4	2 4
10	2.2	2	2	2	2	2.5	2 6	2 6	2 3	2.5
Average......	2.2	2.14	2.26	2.1	2.1	2 44	2.48	2.4	2.28	2 36

Horses with unshod hoofs.

Horse No.	Anterior hoofs.					Posterior hoofs.				
	Toe.	Lateral.		Medial.		Toe.	Lateral.		Medial.	
		Quarter.	Heel.	Quarter.	Heel.		Quarter.	Heel.	Quarter.	Heel.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
3	2 4	2 3	2 4	2 3	2 2	2 5	2.5	2.3	2 5	2.4
4	2 3	2 4	2 3	2.2	2 2	2 5	2.4	2 4	2 4	2.4
7	2 1	2 1	2 2	2.4	2 4	2 6	2 7	2.6	2 4	2.7
8	2 2	2	2 1	2.3	2.2	2.5	2.6	2.5	2.5	2.7
9	2 1	2 2	2	2	2	2.5	2.4	2.5	2 4	2.4
Average...	2.22	2.2	2 2	2.24	2.2	2.52	2.52	2 46	2.44	2.52

a. Average monthly growth of shod hoofs = 9 03 mm.
b. Average monthly growth of unshod hoofs = 9.41 mm.

TABLE IV.—*Summary of the average weekly growth of the hoofs of each horse.*

Horse No.	Age.	Sex.	Color.	Wt.	Ht.	Anterior hoofs.					Posterior hoofs.				
						Toe.	Lateral.		Medial.		Toe.	Lateral.		Medial.	
							Quarter.	Heel.	Quarter.	Heel.		Quarter.	Heel.	Quarter.	Heel.
	Yrs.			*lbs.*	*inch*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1	7	Male....	Bay.... .	480	47	2.4	2.2	2 3	2.1	2	2.3	2.5	2.5	2.5	2.3
2	3½	Male....	Mouse...	500	46	2	2.2	2 4	2 3	2.1	2.5	2.3	2.3	2	2.1
3	10	Female..	Bay......	420	45	2 4	2.3	2.4	2 3	2 2	2 5	2.5	2.3	2.5	2.4
4	8	Male....	Iron Gray	550	49	2 3	2.4	2 3	2 2	2 2	2.5	2.4	2.4	2.4	2.4
5	5	Male....	Black....	535	48	2 2	2 1	2 1	2	2 1	2 4	2 5	2 1	2.2	2.5
6	9½	Male. ..	Cream...	578	51	2.2	2 2	2 3	2 1	2 3	2 5	2 5	2.5	2 4	2 4
7	1¼	Male. ..	Chestnut	454	44	2 1	2 1	2 2	2.4	2 4	2 6	2 7	2 6	2.4	2.7
8	7	Female.	Chestnut.	611	48	2.2	2	2 1	2 3	2 2	2 5	2 6	2 5	2 5	2 7
9	2	Female.	Chestnut.	618	47	2.1	2.2	2	2	2	2 5	2.4	2 5	2 4	2 4
10	9	Female..	Dun . ..	618	50	2 2	2	2	2	2	2 5	2 6	2 6	2 3	2 5
Average...						2 21	2 17	2 21	2 17	2 15	2 48	2 5	2 43	2 36	2 44

a. Average monthly growth of anterior hoof = 8 73 mm.
b. Average monthly growth of posterior hoof = 9 76 mm.
c. Average monthly growth of anterior and posterior hoofs = 9 25 mm.

PARASITES OF LOWER ANIMALS DANGEROUS TO MAN IN THE PHILIPPINE ISLANDS[1]

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It is said that the advance made by any nation is measured largely by its treatment of diseases. In tropical countries one of the biggest problems to be solved before the highest plane of development can be reached is the control of parasitic diseases, those affecting human beings and those the domestic animals suffer from. This assertion is based on the fact that in hot countries zooparasites, which are a great menace to the health and life of man and the lower animals, find conditions of warmth and moisture which are favorable for their existence and propagation. In the Philippine Islands these conditions obtain and so it is to be expected that parasitic diseases would be prevalent. Unfortunately the data which are available at the present time are not sufficient to give us due warning of all the possible dangers in our midst since the field of parasitology, in spite of its importance, has been little exploited here. Judging, however, from the work which has already been accomplished, the indications are that parasitic diseases are exerting unfavorable influences which are not being seriously considered.

It was a common belief not very many years ago that parasites were harmless creatures on which zoologists lavished too much attention. That belief, however, has been shown to be not only erroneous but dangerous, so that at present scientific men put parasites in the same category as other disease-inciting agents. There are parasites like the Egyptian intestinal fluke, *Heterophyes heterophyes*, and others which are claimed by some helminthologists not to cause any visible damage to their hosts; but even these should be regarded with some degree of suspicion because there are certain obscure effects of parasitism which cannot yet be accurately gauged. It should be considered that there must be certain metazoan parasites, as there are certain forms of microorganisms, which seem to possess very little pathogenic power, but, because of their close association with their hosts and the continued application of their pathogenicity they may be able sooner or later to give rise to certain symptoms of disease some of which might have been interpreted as anaphylactic in nature.

It is not the intention of this paper to give a detailed account of the effects of parasitism. Reference, however, should be made to the results of recent investigations bearing on the relationship between meta-and proto-zoan parasites in the production of specific diseases; for they serve to emphasize further the complex significance of parasitic infestation. Theobald Smith and Graybill (1, 2) in their work on blackhead found that the nematode parasite, *Heterakis papillosa*, which is commonly found in the ceca of chickens and other birds, is an important factor in the incidence of the disease. In several controlled ex-

[1] Experiment Station Contribution No. 113. Read at the 11th Annual Meeting of the Philippine Veterinary Medical Association, February 13, 1923.

periments they produced blackhead in turkeys and chickens by feeding them the ripe eggs of the parasite. From their results it was evident that the rôle played by the nematode parasite is either that of an accessory agent which so lowers the resistance of the birds as to make them susceptible even to light infections with *Histomonas* (*Amoeba*) *meleagridis;* or that of an invertebrate host which is able to transmit the organism of blackhead from bird to bird. The latter possibility seems to be supported by the results later obtained by Tyzzer and Fabyan (3). These two investigators after rendering cultures of ripe *Heterakis* eggs bacteriologically sterile by immersion in 1.5% nitric acid solution fed them to young turkeys. Several days after the feeding experiment, the turkeys developed blackhead. Although morphological evidence was lacking to show the presence of *Histomonas meleagridis* inside the nematode eggs, it could only be deduced from their results that the organism of blackhead was contained and protected within the substance of the eggs of *Heterakis papillosa* and that it was liberated in an infectious state when the nematode eggs hatched out in the intestines of the birds.

The significance of these discoveries can readily be appreciated by those who have had field experience and have seen disease outbreaks. What if that which we have been taught to regard as "spontaneous cases" of tetanus, anthrax, blackleg and other diseases are due to the introduction of specific organisms by ingested zooparasite eggs? Some helminth eggs when they hatch liberate larvae which penetrate through the intact walls of the intestines and by so doing they may carry with them, or at least prepare the way for the entrance of, pathogenic organisms present in the intestines. And what if, as in the case of blackhead, rinderpest, hog-cholera and the like can be propagated by the eggs of metazoan parasites? Blackhead is caused by a protozoon which is big enough to be seen under an ordinary microscope. The etiology of rinderpest or of hog-cholera, on the other hand, is supposedly so small as to be invisible with the aid of the most powerful lenses, so that its inclusion within the substance of a helminth egg is more conceivable. Here then is another big problem for anyone who is interested in infectious diseases and in animal parasites. Who would have thought that the Texas fever organism, *Piroplasma bigeminum,* could be transmitted by the cattle tick, *Margaropus annulatus?* Until we have searched everywhere and determined all the possible sources of pathogenic organisms and their methods of entry into the systems of susceptible animals, our efforts to prevent and to eradicate infectious diseases will never be wholly successful.

PARASITES AFFECTING BOTH MAN AND LOWER ANIMALS

Although as a general rule the parasites of different species of animals, including man, are not intertransmissible, there are a few which have been reported to occur both in man and in some of the lower animals. Some of these parasites are found in the Philippine Islands.

ASCARIS LUMBRICOIDES

Ascaris lumbricoides is a very common intestinal parasite of man and the domestic pig throughout the world. The name *Ascaris suilla* has been used to designate the form occurring in the pig, but according to Ransom (4) and others the pig *Ascaris* is morphologically and biologically identical with the *Ascaris* of man.

This roundworm has often been lightly treated in text-books, but because of the recent findings on the real nature of its life-history, it is now considered as one of the most dangerous parasites. Briefly its life-history is as follows: The eggs which are laid by the mature female worm in the small intestines are eliminated with the feces of the host. When these eggs reach the open air, they are in the early stages of segmentation and are not infectious. If they meet with favorable conditions of warmth and moisture on the ground or elsewhere, they continue to segment until after 10 to 14 or more days they become ripe eggs containing motile embryos. At this stage if they are swallowed by a suitable host, they hatch in the intestines. The newly hatched larvae, instead of simply settling down at once to pursue further development, penetrate through the walls of the intestines and are carried by the circulation to the lungs, principally, by way of the liver and heart. They stay in the lungs for a certain length of time, meanwhile increasing slightly in size, and then they follow the course of the bronchioles to the trachea. From the trachea they work their way to the oesophagus and are then swallowed. Finally these developing larvae settle down in the small intestines and continue to grow to maturity.

Ascaris larvae during their migrations through the lungs may affect the host animal seriously. The so-called disease "thumps" of young pigs is attributed to their presence in large numbers in the lungs. They have also been observed to produce pneumonia in these animals. In addition they may act as active mechanical agents in the introduction of pathogenic microorganism into the tissues. Animals which are heavily infested with *Ascaris* larvae are usually stunted in their growth. In human beings, especially in children, similar disturbances with attendant lung symptoms have been reported from various sources. It is, therefore, important to know the relative distribution of this parasite in the Philippine Islands, so that proper preventive measures may be instituted. According to the different parasitological surveys which have been made in various parts of the Islands, 50% to 62% of the population are parasitized with *Ascaris lumbricoides*. In native pigs, on the other hand, the incidence of *Ascaris* infection is less definitely determined. According to the limited number of observations which have been made so far, this parasite is said to be rare in adult Philippine swine. This fact is difficult to believe at first, considering the environment which makes it easy for pigs to pick up *Ascaris* from the soil. One writer (5) is inclined to attribute its scarcity to a possible resistance of Philippine pigs to this worm. Whether or not such a resistance really exists has not been proved by experiment. In this connection it may be of interest to mention the results of autopsies made by Dr. Angel K. Gomez and the writer on fifteen young pigs, not over four months old, sent to us at different times from the Animal Husbandry Department of the College of Agriculture, University of the Philippines. Eight of these, or 53.3%, harbored fairly-well developed but immature *Ascaris lumbricoides* in the small intestines. All the positive pigs were lightly infested, however, the maximum number of worms found in any one of them being five. This evidence, since it concerned only a small number of animals which, too, had all been exposed to practically the same conditions, at about the same time, is not conclusive. It is to be noted, though, that lightness of infestation has been found in older animals so these observations may be used to add weight to the

statement that *Ascaris lumbricoides* is rare in native swine. It seems, however, that it is rare, not in the sense that the pigs are resistant to infection, but rather in the sense that they are very lightly parasitized; for if the percentage of infection (53.3%) is compared with the figures of Ransom and Foster (6) in American swine, it will be shown that the native pig is no less susceptible. Perhaps the failure to find the parasite in many adult native swine is due to the fact that the few worms which might have been picked up during early life are dropped out as the animals grow older.

In the light of these observations it appears likely that we must look for other factors which may be responsible for the scarcity of *Ascaris lumbricoides* in native swine. One of these factors may be concerned with the fact that in the Philippines domesticated animals are not yet crowded together in limited areas of territory. When animals are provided with a wide range, as is the case in the wild state, the danger from infection with parasites is little because the chances of picking them up from the ground are few. Another factor may have to do with the peculiarities of our climatic conditions. In places where the conditions of warmth and moisture do not change much throughout the year, it is possible that parasitic life in the ground can go on uninterruptedly. In the case of many regions of the Philippines, on the other hand, during the dry season the soil gets very warm (43° C. or over) during certain hours of the day. According to our findings (7) on the susceptibility of *Ascaris* eggs to higher temperatures, this heat, applied as it is for certain lengths of time daily, would be high enough to destroy most helminth eggs. Due to this action of the sun's rays there is, therefore, a yearly destruction taking place which prevents a too concentrated infection of the soil with parasite eggs and which lessens the possibilities of infection of animals. In cold countries the same results may not be noted in spite of the radical changes of temperature during winter, for it has been observed that most helminth eggs are better able to stand for longer periods of time low than high temperatures.

The comparative scarcity of *Ascaris lumbricoides* in native swine is a thing in our favor, but it should not make us any less careful because the parasite is very common in man. Prophylaxis consists in the observance of sanitary regulations like the proper disposal of all excreta by the construction of sanitary toilets, in not allowing pigs to roam at large, especially in places where children are apt to play, in pen rotation in the case of swine, etc. Chickens must not be allowed to gain access to human or suilline excreta, for if they swallow the eggs they are able to spread *Ascaris* (7). Young individuals should especially be given prophylactic attention, for they are the most susceptible to infection. For the expulsion of these worms from the intestines oil of chenopodium has been found to be very efficacious. According to Ransom and Hall (8) it is given to swine in doses of 4 mils per hundred pounds of live weight with 2 to 4 ounces of castor oil.

ANCYLOSTOMA DUODENALE AND *NECATOR AMERICANUS*

These intestinal parasites are commonly designated as hookworms. They are responsible for the disease known as ancylostomiasis or hookworm disease which is characterized in man by anemia, dullness, emaciation and digestive disturbances. *Ancylostoma duodenale* is sometimes called the Old World (European) hookworm and *Necator americanus*, the New World (American) hook-

worm. Both forms are present in the Philippines and according to various investigators 31% to 52% of the population are parasitized by either one of them or by both.

Historically[1], ancylostomiasis became known as a serious disease in 1880 during an epidemic of anemia among workers constructing the Saint Gothard tunnel. At first there was much discussion as to the real cause of the malady, some maintaining that it was due to insanitary surroundings. During that controversy the only scientist who insisted on the parasitic origin of the disease was Edoardo Perroncito, a professor of pathology at the Veterinary School of the University of Turin. Since that time several outbreaks of hookworm disease have been reported and suppressed in different parts of the world and especially in the mining districts of Europe. At the present time much eradication work is going on in tropical and subtropical countries, including the Philippines, where the disease is prevalent.

Formerly the methods used in the eradication of hookworm disease were not very satisfactory, for it was not accurately known how the parasite gained entrance into the body. It was believed that infection entered solely through the mouth, but in 1898 Looss showed that the disease can be introduced through the skin. As a result of this important discovery of Looss, prophylactic measures have been modified and are directed to the prevention of soil pollution with hookworm larvae by the proper disposal of human excreta and protection of the exposed parts of the body with proper footwear and gloves. Satisfactory treatment with oil of chenopodium and recently with carbon tetrachloride has aided these preventive measures in reducing the incidence of the disease.

Recently some very interesting facts concerning the propagation of ancylostomiasis by domestic animals have been published. In a series of experiments Ackert (9) has found that hookworm eggs are able to hatch and to develop into infective larvae after passing through the alimentary tract of the domestic chicken. In collaboration with Payne he (10) also determined that hookworm eggs which are swallowed by the domestic pig can later develop into infective stages. In places, therefore, where these two animals, the domestic pig and chicken, can gain access to human excreta, the danger of their spreading the disease is great.

The life-history of a hookworm, including the dog hookworm, is briefly as follows: The eggs which are eliminated with the feces of the host are in different stages of segmentation and they soon hatch if they meet with favorable conditions in the outside world. The newly hatched larvae are, however, not dangerous and they only become infectious after a few days, during which they molt several times. At this stage if they are swallowed by a suitable host, some of them may be able to complete their development in the small intestines. More often, however, the path of infection is through the skin. The infectious larvae by their ability to penetrate through the skin, are carried to the lungs by the circulation. From the lungs they go to the trachea and then work their way to the oesophagus until they are swallowed. In the small intestines they continue to grow to maturity.

Ancylostoma duodenale and *Necator americanus* are parasites of man. They are discussed here due to the possibility of their infecting the dog and other

[1] Bibliography of hookworm disease, Rockefeller Foundation Publication No. 11 (1922).

domestic animals which, because of their habits, may serve as factors in the spread of the disease. In fact there are already on record instances which confirm this view. In 1921 Stiles (11) reported before the Helminthological Society of Washington that in a collection of worms from the dog in the Southern United States, some specimens which are apparently *Necator americanus* are found with *Ancylostoma caninum*, the dog hookworm. Another species, *Ancylostoma ceylanicum*, but which fortunately has not been found in the Philippines, has long been known to infect both man and the dog.

OTHER PARASITES

Lungworms.—A species of lungworm which is apparently *Metastrongylus elongatus* has frequently been found in the lungs of pigs slaughtered at Los Baños. In young animals it is often responsible for the condition known as verminous bronchitis, which often has a fatal termination. It has been reported in human beings from other countries, but in the Philippines not a single case is recorded.

The life-history of this parasite is simple. The eggs hatch in the lungs and the larvae are either coughed out with the bronchial secretion or are swallowed and eliminated with the feces. In the open they develop into infective stages and, if swallowed by a proper host, they work their way through the trachea to the bronchi and bronchioles where they remain to complete their growth. Prophylaxis is a matter of cleanliness. Treatment is not very satisfactory. Herms and Freeborn (12) recommend the injection of chloroform into the nostrils with a medicine dropper in sufficient quantities to produce "grogginess' (about 5 mils in swine).

Tapeworms.—Several species of tapeworms are known to occur in the Philippines. *Taenia saginata*, the larval form of which is *Cysticercus bovis* of cattle and *Taenia solium*, the larval form of which is *Cysticercus cellulosae* of swine, have in several instances been found in Filipinos. These parasites like many others are detrimental to the health and growth of their hosts. In order to prevent infestation with them, meat inspection regulations to do away with carcasses harboring larval tapeworms should be enforced in every locality. This is necessary when it is considered that at least 1% of all the pigs slaughtered in Manila are affected with *Cysticercus cellulosae* (13). No records are at hand for native cattle but it is presumed that they harbor *Cysticercus bovis* due to the existence in man of the adult parasite, *Taenia saginata*.

Dipylidium caninum, a very common parasite of the dog in the Philippine Islands, has been reported by Mendoza-Guazon (14) in a Filipino child. The larval stage lives in the sucking louse of the dog, *Trichodectes canis*, in the dog flea, *Ctenocephalus canis*, and in the human flea, *Pulex irritans*.

The first case of infection with *Hymenolepis diminuta* in a Filipino is recorded by Schwartz and Tubangui (13). This is a very rare parasite of man throughout the world, but in the rat it is quite common. The larval stage is found in the rat flea, *Ceratophilus fasciatus*, and in other insects like the dog and human fleas and in certain beetles according to some investigators.

Flukes.—Of the flukes found in the Philippines two species are known to infect man and some of the lower animals. One is *Paragonimus westermanni*, a parasite of the dog, cat, hog and tiger. Musgrave (15) has reported

seventeen cases in man of paragonimiasis from the Philippines and he has also seen the parasite in one native cat. The fluke is usually located in the lungs giving rise to symptoms which might be mistaken for tuberculosis. Infection with this parasite has often proved fatal There is no satisfactory treatment known. The best that can be done is to institute good hygienic measures and to prescribe rest and general tonics. Prophylaxis consists in the avoidance of the intermediate hosts of the parasite. According to Japanese writers the first intermediate hosts are fresh water snails belonging to the genus *Melania* in which the miracidia coming from the eggs of the mature fluke develop into sporocysts, rediae and cercariae. The cercariae, on leaving the snails, go to encyst in the bodies of certain crabs which, if eaten raw or not sufficiently cooked, will transmit the parasite. In the Philippines species of Melania snails are abundant in fresh water rivers and creeks, but it is not known if they harbor the larval stages of *Paragonimus westermanni*.

The liver fluke, *Fasciola hepatica*, of cattle and other herbivores is very prevalent. Musgrave (15) also records one case of infection in man with this parasite from the Philippines. The larval stages of *Fasciola hepatica* are spent in snails (Genus *Limnaeus*). The cercariae usually encyst on blades of grass but occasionally they may also encyst in water. Man probably gets the infection by drinking water which contains these cysts. The specific intermediate host of this parasite has not been determined in the Philippines although it is presumably a snail. Prophylaxis consists in not putting animals on low pastures and in the destruction of snails which act as intermediate hosts by proper drainage or by treating the water with chemical poisons like copper sulfate, salt or lime. A very satisfactory method of treatment is not known although it is claimed that oleoresin of male fern in doses of 12 to 25 grams and powdered kamala in amounts of 15 grams, given in 1 to 5 gram doses, for cattle have given good results.

CONCLUSION

There are many important parasitic diseases in the Philippine Islands which could have been described, but only those which may affect both man and some of the lower animals have been chosen with the aim of arousing a common interest among scientific men who by their training are considered leaders in public sanitation and hygiene. As has been stated elsewhere, ours is a tropical country where the dangers from parasites are great, and unless proper measures are taken all efforts to reach the highest plane of development will always be seriously impeded. It is no longer for us to doubt the retarding and degenerating effects of parasitism because they have been demonstrated in the history of many nations. Around us there are telling facts which are undoubtedly due to parasitic influences. It is for the physicians, veterinarians and other scientists to warn the public and to teach it how to avoid parasites. The government is doing its share in having the subject of parasitology taught in our University, but it can go further by giving more encouragement for research to those who are interested. The urgent need for this is evident when it is considered how many losses in life and property and how much suffering are sustained every year from the ravages of malaria, hookworms, surra, dysentery and many other diseases which are caused by zooparasites.

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RULES FOR THE PURPOSE OF PREVENTING THE INTRODUCTION OF COMMUNICABLE DISEASES OF ANIMALS[1]

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The following rules should be adhered to by persons in charge of livestock for the purpose of preventing the introduction of communicable diseases of animals as well as preventing the spread of these diseases should they occur.

1. When cattle, carabaos, or other animals are purchased, they should always be treated as having been exposed to infection.

2. When animals are being moved from one locality to another, they should not be allowed to mix with other animals "en route". They should travel during the cool time of the day.

3. When cattle and carabaos are purchased, on being brought to the purchaser's premises, they should be kept by themselves and not allowed to mix with the old cattle of the farm in the pasture, at the watering place or at any other place. They should be kept by themselves for at least one month in order to ascertain whether or not they are affected with a contagious disease. During that time the newly purchased cattle and carabaos should be carefully inspected morning and evening, and if any disease appears among them the affected animals should be isolated at once and the services of a veterinarian secured. The remaining animals should be separated into smaller lots and picketed at some distance apart. At the end of one month, if no disease has appeared among them, they may be safely pastured and kept with the other carabaos and cattle.

4. When cattle and carabaos are traveling, or are moved from one district to another, they are likely to be exposed to contagion and may contract disease; therefore, on their arrival at home, they should be carefully inspected, and if they have passed through an infected district they should be kept by themselves for sometime.

5. When a disease of a contagious nature, or supposed to be of contagious nature, appears among animals, the first important duty of a person in charge of the stock is to separate the sick from the healthy ones.

6. Carefully inspect all the animals, and remove to a place designated as the hospital any animal showing the slightest symptom of disease.

7. Divide the healthy animals into several lots, making each lot as small in number as space will permit. Picket the animals in such lots a good distance apart, and to the windward of the sick animals. Frequently inspect each lot and remove at once any animal showing symptoms of disease. By following this plan strictly the disease will be found in a few days to exist only among one or two lots, and by removing at once to the hospital any sick animals the disease will be speedily arrested and will not spread throughout the herd.

8. The hospital for the diseased animals should be isolated and enclosed with a strong fence. The sick animals should not be permitted to leave the isolated

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[1] Experiment Station Contribution No. 114.

area. The attendants should not be allowed to leave the hospital without changing their clothes and disinfecting their hands and feet. Food and water may be taken to the attendants and to the sick animals, but no forage, or water or litter, or clothing or anything should be taken from the hospital. DOGS SHOULD NOT BE ALLOWED TO GO TO AND FROM THE HOSPITAL AS THEY MAY CARRY CONTAGION TO PLACES WHERE HEALTHY STOCK ARE LOCATED.

9. The dry litter and other waste of the hospital should be burned inside the hospital area, and the moist dung and discharges should be frequently removed from the stalls and buried in pits dug in the hospital premises. These pits should be six feet or more deep, and should be filled with the wet litter, dung, etc., of the hospital up to within two feet of the surrounding ground surface and then quick-lime and good fresh earth should be used to fill up the remaining two feet.

10. The hospital should be disinfected frequently and should be kept in a sanitary condition It should have good ventilation.

11. The constant burning of sufficient litter, opposite the doors on the windward side of the buildings is a good plan in seasons when flies are troublesome to animals. Flies are frequently agents for spreading disease.

12. The sick animals should be kept scrupulously clean and have thin rice gruel and fresh green grass for diet. The healthy animals should be kept clean also and should be kept on soft laxative food as cattle and carabaos fed on hard, dry food develop the disease in a more severe form than those fed on laxative fodder.

13. When contagious diseases have prevailed among cattle and carabaos they should not be allowed to pasture with unaffected herds until one month has expired after the last case of disease occurring among the affected lot.

14. Animals that recover should be well washed with warm water and soap prior to being removed from hospital, and if obtainable, enough carbolic acid should be added to the warm water to make a 2% solution.

15. Carcasses of animals that die from contagious disease should be burned whole whenever possible on the spot where the animal died. If burning is not practicable they should be buried deep and covered with at least 4 feet of earth. The hides of the animals that die from communicable diseases should be destroyed with the carcasses.

16. The top surface of the earth, of stalls, or any ground on which animals affected with contagious diseases have been kept, should be removed and buried, and the earth below should be well dug up and turned over and remade with fresh earth. If the floor is of wood, brick, stone, or cement, it should be scraped, washed, and disinfected with quick-lime or carbolic acid.

17. The poles of carts or harness or saddlery, etc., used by animals affected with contagious diseases should be washed and disinfected. If not of much value, it is better to burn them.

18. The periods of incubation of rinderpest, haemorragic septecimia, anthrax, foot and mouth disease, etc., are well within the period of 28 days; so a month has been named as ample time for an animal supposed to have been exposed to the contagion of these diseases, to be kept isolated. When contagious pleuropneumonia is suspected the time of observation should be extended to at least three months.

19. The application of the above rules in all cases of contagious, infectious and communicable animal diseases is essential; but in case of the diseases for which a preventive inoculation has been devised, they can in many cases be modified and made less irksome. Disinfection in every way is always essential; but if animals are protected against a disease, measures of segregation can in many cases be relaxed. Professional assistance should always be obtained if available and preventive inoculation instituted.

STABLE FLOORS[1]

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The question of floors and flooring probably gives rise to more discussion and divergence of opinion than any other single feature in the construction of animal habitations. The difficulty lies in the fact that three distinct classes of requirements must be recognized and catered to as far as possible, namely, the owner's, the animal's, and the sanitarian's. The owner demands that the floor be durable and economical, the animal requires that it be safe and comfortable, and the sanitarian that it possess hygienic features. It is needless to say that this is a combination of properties difficult to obtain in any one matetial; in fact, it is impossible to find any one material in use at the present time which embodies them all. The flooring of buildings intended for horses is always a more complicated matter than when other species of animals are to be housed, the reasons for this being that horses are of relatively greater weight, are shod with iron and steel and are often addicted to frequent stamping. Our attention is mainly directed to that phase of the question which deals with horses and the demands in the way of stable flooring which their presence creates. The same general remarks will apply where other species are involved, due allowance, of course, being made for modification of details.

THE REQUIREMENTS FOR AN IDEAL FLOOR

As previously mentioned, a floor must be durable, not only for economic reasons but from a sanitary standpoint as well. In order to insure durability it is imperative that all floors, no matter of what material, rest on a solid, firm foundation. The most satisfactory way of providing this is by excavating the earth to a depth of five to six inches and laying a bed of well tamped, crushed rock covered with concrete. A floor not laid on a compact foundation will sink in places and if made of concrete will crack. The crevices and depressions collect and retain water and urine and through constant saturation tend to subside still further resulting in a rough uneven surface. In addition they lead to the evolution of offensive gases of decomposition due to the polluted condition of the subsoil.

The more hard and dense is the structure of a floor, the more impervious it will be to moisture. The hardness adds materially to its wearing qualities since absorption of moisture together with constant pressure is the principal cause of disintegration. A floor with a hard, compact, impervious surface is, therefore, lasting besides presenting a most important hygienic feature. Unfortunately, however, the surface of such a floor is smoother than one less compact which makes it, particularly when wet, slippery. The accumulation of dirt, especially that of a greasy nature, in the small pores of the surface increases the smoothness as does also the polishing effect which results from friction with animals' shoes passing over it. Although a floor with a hard, compact surface

[1] Experiment Station Contribution No. 115.

is objectionable from the horse's standpoint for the reason stated, it is most desirable from that of the hygienist. Thorough cleaning is facilitated and drying occurs quickly. There is no absorption of urine by the material nor lodgement of particles of solid excreta. This feature assumes additional importance when the fact is borne in mind that the animal while stabled is securely confined to a rather restricted area and must of necessity live and eat in the same place and rest on the same floor where it defecates and urinates.

Another essential requirement for a hygienic floor is non-porosity. The importance of this is due to the necessity of preventing the permeation of the subsoil with urine and other decomposing organic matter. Rise and fall of the ground water is constantly occurring and it imparts its movement to the soil air above. During the rise of the ground water, soil emanations are forced out and where surface pollution is great, as in the neighborhood of inhabited buildings, it is a common cause of vitiated atmosphere. Furthermore, the air within a building, especially one with walls, is generally warmer than the outside atmosphere and owing to the higher temperature the structure acts as a suction pump to the soil on which it stands. While no specific disease of animals can be pointed to as directly attributable to the breathing of impure air, yet it contributes together with other insanitary conditions to a general lowering of the vitality and hence of the animal's body resistance.

To the foregoing features others must be added if all the requirements of an ideal floor are to be met. The animal demands an even level surface, not too hard and compact, but one slightly yielding so that it may relax the muscles and supporting structures of its limbs while standing. Safety from accidents requires that the floor be not slippery. On lying down the surface must be free from dampness and not too hard. Sanitation requires that the floor be well drained, gradually sloping towards the rear at a gradient of about one in seventy. Inasmuch as the keeping of animals, is usually a business matter, the owner demands a small initial cost and infrequent cheap repairs.

FLOORING MATERIALS

While there are several materials which may be used for flooring, there is one which stands out pre-eminently. Everything considered, cement-surfaced concrete unquestionably makes the best all-round floor and, while not be any means perfect, it approaches more closely an ideal structure than does any other material. Of all the materials in common use it is the most durable if properly laid and is relatively cheapest. It is non-absorbent and for all practical purposes non-porous. It is easily drained and cleaned and affords an even, level standing surface from which water evaporates quickly. Such floors are frequently objected to on the ground that they are slippery. This defect may be overcome to a considerable extent by grooving the surface in straight lines. The grooves should be not less than one half inch deep and should run, as nearly as possible, at right angles to the direction usually taken by animals entering or leaving the building. Arrangement of the grooves in herring-bone fashion is preferable to a checkered pattern as cleaning is facilitated. Cleaning the floor with a stiff wire brush tends to preserve a slight roughness of the surface and overcomes the effects of friction and prevents the lodgement of dirt. While concrete floors are held responsible for many accidents, especially to horses, an investigation will usually disclose that other factors besides the

slippery surface have been a contributory cause. In stables where accidents occur the passage-way at the rear of the stalls will generally be found to be too narrow and the turnings at doors and other passages too sharp and abrupt. Improper handling of animals, consisting principally in rushing them in and out of a building, is another fruitful source of mishaps. It has been shown from experience that if animals are not hurried, turned slowly, and not frightened, accidents due to slipping become a negligible factor in stabulation. Concrete floors have been in use in many stables for years without giving rise to a single complaint in this regard.

Another shortcoming of a concrete floor is that owing to its hardness it is tiresome for the animal to stand on. As most animals however spend a considerable portion of their time outside of the stable and lie down frequently when within this drawback cannot be considered as serious.

Granite blocks set in concrete and various patterns of vitrified brick provide a fairly satisfactory pavement although their surfaces are slippery. Ordinary building bricks are too porous and being soft they wear rapidly and unevenly so that the life of the floor is short. Wooden floors are objectionable from a sanitary standpoint as they absorb moisture, and rapidly wearing into holes, are not durable. Even wooden blocks treated with creosote are more or less absorbent and their use cannot be recommended. Earthen floors possess the one virtue of being comfortable for the animal to stand on, otherwise their defects are so evident that they may be dismissed without consideration.

As a final comment it may be said that the superiority of cement-surfaced concrete floors is so clearly proved as to entitle them to be regarded as the "last word" in the paving of buildings occupied by animals and their construction is strongly urged by the writer. The constantly increasing use and popularity of these floors indicates a general recognition of their merits which must in time lead to their almost universal use.

COLLEGE AND ALUMNI NOTES

Mr. Joaquin J. Gonzalez, 1919, who is farming in Apalit, Pampanga, continues to perform co-operative work for the Plant Breeding Division of this College. Mr. Gonzalez has just secured several sacks of cuttings of a promising sugar cane seedling variety, produced here by Dr. Mendiola for propagation and test in his farm.

Dr. Mendiola made two trips to the Central Provinces during March. One to the Rice Station of the Bureau of Agriculture at Rosales, Pangasinan, and the other to the Central Luzon Agricultural School at Muñoz, Nueva Ecija.

Arrangement has been made with the Bureau of Agriculture and the Rosales station by which pedigree strains of College rice will be tested in that place. A very important agronomy problem which he found at the Rosales Station and in which our Agronomy Department should be interested is the finding of rice varieties suitable for summer culture under irrigation. The importance of the problem may be realized when it is considered that in a few years thousands of hectares of rice land will be under summer cultivation as a result of the completion of the several irrigation projects now being undertaken by the Government.

The trip to the Central Luzon Agricultural School included a trip to the main site of the Talavera irrigation project. Four alumni of this college are in the faculty of the Central Luzon Agricultural School and these are taking very active part in running that institution. These men believe that a department of rural education should be established in this College for the training of agricultural teachers who will be in great demand as the number of agricultural schools is increased.

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THE OUTPUT OF THE COLLEGE OF AGRICULTURE

By C. F. Baker

Dean, College of Agriculture

"By their fruits ye shall know them." The College of Agriculture should be judged by its actual output. The output is of two sorts: First, and most important, is the human product; and second, the investigational and study results. The human product may be placed in three classes, the graduates forming two classes, and the short course students, one class.

Of great importance is that small group of graduates who have gone on into advanced work in America and who have obtained the best preparation that man can have in the special lines of agricultural sciences which they have chosen. This group is listed hereinafter as returned fellows. In my opinion, if the College had done no more than to produce this group, still it would have amply justified its existence, since in this group rests the possibility of carrying on the College of Agriculture and the great work which it represents.

The remaining graduates of the College represent the second most important group. The following list shows what has become of these graduates. During the earlier years of the College, the graduates were urgently sought for Government service, since Filipinos with this kind of preparation had not before existed in the country. As the requirements of the Bureaus became partly satisfied, more and more of the graduates turned to active private work, and numbers of them are now very successful farmers in many parts of the Islands. The College of Agriculture cannot produce one hundred per cent successes any more than can any other educational institution. All of the graduates of our best colleges of law and medicine are not successes. Also, it must be remembered in connection with the human product that its value cannot be gauged or realized upon, on short notice. We cannot teach common sense or mature judgment, nor endow any young man with sufficient working experience. The "University of Hard Knocks" must top off the work of the College of Agriculture, and we cannot estimate the real value of any man short of, say, five years after graduation. The possible usefulness of graduates of the College of Agriculture and the extent of fields in which they may serve has been greatly increased by the establishment of first class special courses in sugar technology and in animal husbandry.

The third class consists of the large proportion of the students, numbering several thousand young men, who have been at the College of Agriculture from one to three years but who did not graduate. These short-course men are now scattered all over the Islands, and a majority of them are in active private work.

Many of them have turned out great successes and some of them today are men of wealth—the majority of them doing their part in the material development of the Islands.

In spite of the fact that there has been no special support for Experiment Station work at the College of Agriculture, still the output in original results has been very considerable due to the permanent policy of the College in requiring every member of its faculty to be intellectually active and a producer of knowledge as well as a teacher. The attached list of experiment station contributions is ample evidence of the great extent and value of this output, and of the wisdom of the policy which has brought it about. The claim has been made in years gone by that opportunities for original work by Filipinos were greater at the College of Agriculture than in any other department of the Government, and the actual results would seem to bear this out.

FELLOWS AND PENSIONADOS OF THE COLLEGE OF AGRICULTURE RETURNED TO SERVICE

MANUEL L. ROXAS, Ph. D.,

Matriculated for graduate studies in the University of Wisconsin, July, 1914, receiving the degree of *Doctor of Philosophy* in 1916; special studies in Massachusetts Institute of Technology.

Professor of Chemistry, Acting Head of Department, College of Agriculture, University of the Philippines.

B. M. GONZALEZ, D. Sc.,

Matriculated for graduate studies in the University of Wisconsin, October, 1914, receiving the degree of *Master of Science*, 1916; *Professor of Animal Husbandry, College of Agriculture, University of the Philippines;* matriculated for additional graduate studies in Johns Hopkins University, May, 1921, receiving the degree of *Doctor of Science* (in Hygiene) in 1923.

Professor of Animal Husbandry, Head of Department, College of Agriculture, University of the Philippines.

N. B. MENDIOLA, Ph. D.,

Matriculated for graduate studies in Cornell University, August, 1916, receiving the degree of *Doctor of Philosophy* in 1918.

Associate Professor of Agronomy (Plant Breeding) *College of Agriculture, University of the Philippines.*

R. B. ESPINO, Ph. D.,

Matriculated for graduate studies in Johns Hopkins University, June, 1917, receiving the degree of *Doctor of Philosophy* in 1919.

Assistant Professor of Crop Physiology, College of Agriculture, University of the Philippines.

JOSÉ J. MIRASOL, Ph. D.,

Matriculated for graduate studies in University of Illinois, October, 1918, receiving the degree of *Doctor of Philosophy* in 1920.

Dean of the Junior College and Professor of Agriculture, University of the Philippines.

FRANCISCO A. QUISUMBING, Ph. D.,

Matriculated for graduate studies in Columbia University, September, 1918, receiving the degree of *Doctor of Philosophy* in 1921.

Assistant Professor of Chemistry, College of Liberal Arts, University of the Philippines.

L. B. UICHANCO, D. Sc.,

Matriculated for graduate studies in Bussey Institute, Harvard University, August, 1919, receiving the degree of *Doctor of Science* in February, 1922.

Assistant Professor of Entomology, Acting Head of Department, College of Agriculture, University of the Philippines.

FRANCISCO M. FRONDA, Ph. D.,

Matriculated for graduate studies in Cornell University, September, 1919, receiving the degree of *Doctor of Philosophy* in 1922.

Instructor in Poultry Husbandry, College of Agriculture, University of the Philippines.

F. O. SANTOS, Ph. D.,

Matriculated for graduate studies in Yale University, 1919, receiving the degree of *Doctor of Philosophy* in 1922.

Assistant Professor of Chemistry, College of Agriculture, University of the Philippines.

VALENTE VILLEGAS, Ph. D.,

Matriculated for graduate studies in Iowa State College, 1919, receiving the degree of *Doctor of Philosophy* in 1922.

Assistant Professor of Animal Husbandry, College of Agriculture, University of the Philippines.

ANASTASIO L. TEODORO, M. Sc.,

Matriculated for graduate studies in Cornell University, 1919, receiving the degree of *Master of Science* (in Agricultural Engineering) in 1921.

Instructor in Agricultural Engineering, College of Agriculture, University of the Philippines.

EDUARDO QUISUMBING, Ph D,

Matriculated for graduate studies in the University of Chicago, October, 1920, receiving the degree of *Doctor of Philosophy* in 1923

Instructor in Plant Physiology, College of Agriculture, University of the Philippines.

GERARDO OFFIMARIA OCFEMIA, Ph. D.,

Matriculated for graduate studies in University of Wisconsin, 1920, receiving the degree of *Doctor of Philosophy* in 1923.

Instructor in Plant Pathology, Acting Head of Department, College of Agriculture, University of the Philippines.

CECILIO ALINCASTRE, M. S.,

Matriculated in Massachusetts Institute of Technology, 1920, receiving the degree of *Bachelor of Science* (in Mechanical Engineering)

Matriculated for graduate studies in Audubon Sugar School, 1922, receiving the degree of *Master of Science* in 1923

Instructor in Sugar Technology, College of Agriculture, University of the Philippines.

TORIBIO VIBAR, Ph. D.,

Matriculated for graduate studies in the University of Illinois, 1921, receiving the degree of *Doctor of Philosophy* in 1923.

Assistant Professor of Agronomy, College of Agriculture, University of the Philippines.

ALUMNI OF THE COLLEGE OF AGRICULTURE[1]

CLASS OF 1911

Bachelor of Science in Agriculture

ROXAS, MANUEL L., M.S. (Univ. Phil) Ph. D. (Univ. Wis.)
Professor of Agricultural Chemistry, Acting Head of Department, College of Agriculture, University of the Philippines, Los Baños, Laguna

Bachelor of Agriculture

TEMPONGKO, CLODOALDO
Deceased.

ZAMORA, JOSÉ, *Master Farmer* (Univ. Phil.)
Farmer, Silang, Cavite.

CLASS OF 1912

Bachelor of Science in Agriculture

ALLAREY, VICENTE
Farm Adviser, Bureau of Agriculture, Lucena, Tayabas.

[1] The list was prepared by the Registrar, College of Agriculture (Registrar's Circular No. 42 s. 1923-24) from such records as were available. Corrections as to occupation and residence are requested.

Bachelor of Agriculture

ASUNCION, SILVESTRE, M.S. (Audubon Sugar School)
Sugar Technologist, Bureau of Agriculture, Manila.

CEVALLOS, FELIPE, M.S. (Univ. Wis.)
Occupation and residence unknown.

NAVARRO, ANDRES, M.D. (Univ. Phil.)
Captain, Philippine Constabulary, Baguio, Mt. Prov.

VIBAR, TORIBIO, B.S.A., M.S. (Univ. Phil.), Ph. D. (Univ. Ill.)
Assistant Professor of Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna.

CLASS OF 1913

Master of Science

ROXAS, MANUEL L.
See Class of 1911, Bachelor of Science in Agriculture, supra.

Bachelor of Science in Agriculture

CRISOSTOMO, MARCELO
Farm Adviser, Bureau of Agriculture, Iloilo, Iloilo.

LEDYARD, EDGAR M.
Director, Agricultural Department, United States Smelting Co., Salt Lake City, Utah.

Bachelor of Agriculture

ALBANO, SOTERO F.
Fiber Inspector, Bureau of Agriculture, Vigan, Ilocos Sur.

BAGUI, FLORENCIO G.,
Principal, Farm School, Bureau of Education, Batangas, Batangas

BARTOLOME, VICENTE C.
Assistant Chief, Fiber Division, Bureau of Agriculture, Manila.

GONZALEZ, BIENVENIDO M , M.S. (Univ. Wis), D Sc. (Johns Hopkins Univ.)
Professor of Animal Husbandry, Head of Department, College of Agriculture, University of the Philippines, Los Baños, Laguna.

LEJANO, ANTONIO
Fiber Inspector, Bureau of Agriculture, Manila.

MUÑOZ, APOLONIO R.
Farmer, Juban, Sorsogon.

VILLEGAS, VALENTE E., Ph.D. (Iowa State College)
Assistant Professor of Animal Husbandry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

CLASS OF 1914

Bachelor of Science in Agriculture

MENDIOLA, NEMESIO B., M.S. (Univ. Phil.), Ph.D. (Cornell Univ.)
Associate Professor of Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna.

Bachelor of Agriculture

ADRIANO, ALFREDO P.
Merchant, Tokyo, Japan.

CAMUS, JOSÉ S.
Assistant Chief, Division of Extension and Demonstration, Bureau of Agriculture, Manila.

GALANG, FRANCISCO
Chief, Division of Plant Industry, Bureau of Agriculture, Manila.

LAPARAN, AMANDO
Farm Adviser, Bureau of Agriculture, Santa Cruz, Laguna.

MERINO, GONZALO F.
Chief, Division of Pest Control, Bureau of Agriculture, Manila.

QUISUMBING, FRANCISCO A., M.S. (Univ. Phil.), Ph.D. (Columbia Univ.)
Assistant Professor of Chemistry, College of Liberal Arts, University of the Philippines, Manila.

SABLAN, ELADIO
Technical Employee, Fiber Division, Bureau of Agriculture, Manila.

TIRONA, JOSÉ P., M.D. (Univ. Phil.)
Farmer and Physician, Cavite.

ZULAYBAR, EUTIQUIO Q.,
Fiber Inspector, Bureau of Agriculture, Calbayog, Samar.

CLASS OF 1915

Bachelor of Science in Agriculture

ALDABA, VICENTE C., M.S. (Univ. Phil.)
Instructor in Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna; Fellow at Lowell Textile School, Lowell, Mass.

AURELIO, CATALINO C.
Principal, Banga Agricultural School, Bureau of Education, Banga, Capiz

DACANAY, JOSÉ Q.
Chief, Division of Publications, Bureau of Agriculture. Manila.

MIRASOL, JOSÉ J., M.S. (Univ. Phil.), Ph.D (Univ. Ill.)
Dean, Junior College, University of the Philippines, Cebu, Cebu.

TEODORO, NICANOR, M.S, Ph.D. (Univ. Wis.)
Plant Pathologist, Bureau of Agriculture, Manila.

UICHANCO, LEOPOLDO B., M.S (Univ. Phil.), M S., Sc D. (Harvard Univ.)
Assistant Professor of Entomology, Acting Head of Department, College of Agriculture, University of the Philippines, Los Baños, Laguna

Bachelor of Science in Forestry

RACELIS, ANTONIO, M.S.F. (Mich. Univ.)
Forester, Bureau of Forestry, Manila.

VILLAMIL, ANICETO
Farmer, Oriental Negros.

Bachelor of Agriculture

CAPISTRANO, SEVERO M.
In Charge, Singalong Experiment Station, Bureau of Agriculture, Manila.

CONSTANTINO, AGRIPINO
Teacher, Rizal Provincial High School, Bureau of Education, Pasig, Rizal.

ESPINO, RAFAEL B., Ph D. (Johns Hopkins Univ.)
Assistant Professor of Crop Physiology, College of Agriculture, University of the Philippines, Los Baños, Laguna.

GHOFULPO, TEODORO G.
Technical Employee, Binalbagan Sugar Central, Binalbagan, Occidental Negros.

LABAYAN, SEGUNDO D., M.S (Audubon Sugar School)
Technical Employee, Talisay Sugar Central, Talisay, Occidental Negros.

MARQUEZ, FRANCISCO D.
Superintendent, La Carlota Experiment Station. Bureau of Agriculture, La Carlota, Occidental Negros.

MIRAFLORES, JOSÉ C.
Chemist, Manapla Sugar Central, Manapla, Occidental Negros.

MONTELLANO, PEDRO L., M.S. (Univ. Wis.).
Teacher, Central Luzon Agricultural School, Bureau of Education, Muñoz, Nueva Ecija.

OCFEMIA, GERARDO O., M.S. (Univ Phil.), Ph.D. (Univ. Wis.)
Instructor in Plant Pathology, Acting Head of Department, College of Agriculture, University of the Philippines, Los Baños, Laguna.

OTUBRE, FRANCISCO P.
In Charge, Rosales Experiment Station, Bureau of Agriculture, Rosales, Pangasinan.

PANGANIBAN, ELIAS H., B.S.A., M.S. (Univ. Phil.)
Instructor in Chemistry, College of Agriculture, University of the Philippines, Los Baños, Laguna; Fellow in Cornell University, Ithaca, New York.

SARMIENTO, RAMÓN B.
Deputy Governor of Agusan, Butuan, Agusan.

VELEZ, BLAS C.
Technical Employee, Tanaraw Plantation Co., San José, Mindoro.

VICENCIO, ARSENIO S.
Farm Adviser, Bureau of Agriculture, Mexico, Pampanga.

VISTA, TOMAS I., M.S. (Univ. Phil.)
Farmer, Rizal, Laguna.

CLASS OF 1916

Master of Science

CLINTON, GUY, B.S. (Shenandoah Coll.)
Residence in the United States, occupation not reported.

ELAYDA, INOCENCIO, B.S.A. (Iowa State College)
Director of Extension Service, College of Agriculture, University of the Philippines, Los Baños, Laguna.

MENDIOLA, NEMESIO B.
See Class of 1914, Bachelor of Science in Agriculture, supra.

Bachelor of Science in Agriculture

PAGUIRIGAN, DOMINGO B., M.S. (Conn. Agr. Coll.)
Technical Employee, Bureau of Internal Revenue, Manila.

Bachelor of Agriculture

BACOMO, PANTALEON U.
Farm Adviser, Bureau of Agriculture, Puerto Princesa, Palawan.

BALANGUE, CORNELIO R.
Farm Adviser, Bureau of Agriculture, Tuguegarao, Cagayan.

CAGURANGAN, ALFONSO B.
Farm Adviser, Bureau of Agriculture, Ilagan, Isabela.

CONSTANTINO, MARCELINO
Farm Adviser, Bureau of Agriculture, Tanza, Cavite.

CONSUNJI, GAUDENCIO
Farmer, Hermon, Bataan.

CRUZ, FLORENTINO F., *Master Farmer* (Univ Phil.)
Manager, Crescent Star Cattle Co., Dagumbaan, Bukidnon.

DAWIS, VICENTE M., B.S.A. (Univ Phil.)
Assistant Farm Superintendent, College of Agriculture, University of the Philippines, Los Baños, Laguna.

LEON, JOSÉ DE
Superintendent, Lamao Experiment Station, Bureau of Agriculture, Limay, Bataan.

PALAFOX, GAUDENCIO
Superintendent, Damao Experiment Station, Bureau of Agriculture, Damao, Isabela.

SAN MIGUEL, LUCIO A.
Deceased.

CLASS OF 1917

Master Farmer

ZAMORA, JOSÉ
See Class of 1911, Bachelor of Agriculture, supra.

Master of Science

MIRASOL, JOSÉ J.
See Class of 1915, Bachelor of Science in Agriculture, supra.

Bachelor of Science in Agriculture

ABADILLA, FRANCISCO
Farmer, Lucena, Tayabas.

FRANCISCO, GREGORIO, *Master Farmer* (Univ. Phil.)
Farmer, Santa Rosa, Nueva Ecija.

GUTIERREZ, MARIANO E.
Deputy Governor of Cotabato, Cotabato, Cotabato.

MEDALLA, MARIANO, M.S. (Univ. Phil.)
Assistant Plant Pathologist, Bureau of Agriculture, Manila.

MENDOZA, LEOPOLDO G.
Farmer, Sagnay, Camarines.

SARAO, FELIX B., M.S. (Univ. Wis.)
Instructor in Animal Husbandry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

SILAYAN, HILARION
Student in the United States.

Bachelor of Agriculture

CALINGASAN, TEOFILO
Farm Adviser, Bureau of Agriculture, Malabalay, Bukidnon.

CLEMENTE, LEOPOLDO, Ph.D. (Univ. Ill.)
Instructor in Zoology, Junior College, University of the Philippines, Cebu, Cebu.

EDROSO, LEON
Superintendent of Abulug Colony, Bureau of Lands, Abulug, Cagayan.

FLORES, SIMEON
Farm Adviser, Bureau of Agriculture, Dumaguete, Oriental Negros.

GOCO, ARSENIO A.
Inspector, Division of Pest Control, Bureau of Agriculture, Manila.

GRAGEDA, GREGORIO
Teacher, Bureau of Education, Siassi, Jolo.

PASTORFIDE, DIONISIO B.
Farm Adviser, Bureau of Agriculture, Lucena, Tayabas.

PAULICAN, CENON
Manager, Dagumbaan Cattle Ranch, Dagumbaan, Bukidnon.

REYES, SIMEON
Inspector, Division of Pest Control, Bureau of Agriculture, Manila.

TUASON, DIONISIO
Deceased.

VILLYAR, PAULO
Technical Employee, Alabang Stock Farm, Bureau of Agriculture, Alabang, Rizal

CLASS OF 1918

Master of Science

COCANNOUER, JOSEPH A., B. Agr.
Principal, High School, Chowchilla, California.

QUISUMBING, FRANCISCO A.
See Class of 1914, Bachelor of Agriculture, supra.

UICHANCO, LEOPOLDO B.,
See Class of 1915, Bachelor of Science in Agriculture, supra.

Bachelor of Science in Agriculture

BAUTISTA, PANTALLON
Farmer, Malabon, Rizal.

TRINIDAD, JOSÉ
Manager, Unson Coconut and Cattle Co., Parang, Cotabato.

Bachelor of Agriculture

AFRICA, EMILIO A.
Manager of . . Plantation, Hagonoy, Cotabato.

ARAGON, VICENTE
Farm Adviser, Bureau of Agriculture, Tarlac, Tarlac.

BAUTISTA, BASILIO
Farm Adviser, Bureau of Agriculture, Pasig, Rizal.

BAYLA, ARSENIO
Technical Employee, Bureau of Agriculture, Manila.

FESTIN, SANTIAGO
Farmer, residence unknown.

LAYOSA, PEDRO
Deceased.

MACASAET, VALENTIN
Agricultural Supervisor, Iwahig Penal Colony, Bureau of Prisons, Iwahig, Palawan.

MARIANO, JOSÉ
Inspector, Bureau of Agriculture, Malolos, Bulacan

OTANES, FAUSTINO, B.A., M.S., Ph.D. (Univ. Ill.)
Technical Employee, Division of Pest Control, Bureau of Agriculture, Manila.

PAZ, ALFONSO DE LA
Animal Husbandman, Lipa Experiment Station, Bureau of Agriculture, Lipa, Batangas.

QUISUMBING, EDUARDO, Ph.D. (Univ. Chicago).
Instructor in Plant Physiology, College of Agriculture, University of the Philippines, Los Baños, Laguna.

ROMERO, LEON
Farm Adviser, Bureau of Agriculture, San Carlos, Pangasinan.

SAMONTE, CLARO
Farm Adviser, Bureau of Agriculture, Bayombong, Nueva Vizcaya.

SANTOS, FRANCISCO B.
Farm Adviser, Bureau of Agriculture, Laoag, Ilocos Norte.

SANTOS, GREGORIO
Technical Employee, Bureau of Agriculture, Manila.

TEODORO, ANASTASIO, M.S. (Cornell University)
Instructor in Rural Engineering, College of Agriculture, University of the Philippines, Los Baños, Laguna.

CLASS OF 1919

Master of Science

SANTOS, FRANCISCO O., A.B., B.S. (Univ. of Phil.)[1], Ph.D. (Yale Univ.)
Assistant Professor of Chemistry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

Bachelor of Science in Agriculture

CHANCO, ANTONIO R.
Technical Employee, Bureau of Agriculture, Manila.

HABALUYAS, RAMON K., M.S. (Univ. Phil.),
Chemist, Malabon Sugar Co., Malabon, Rizal.

VENTURA, TRANQUILINO
Chemist, Pampanga Sugar Development Co., San Fernando, Pampanga.

Bachelor of Agriculture

ADRIANO, FELIPE T., M.S. (Univ. Wis.)
Assistant Professor of Chemistry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

ALCASID, EXEQUIEL
Superintendent, Alabang Stock Farm, Bureau of Agriculture, Alabang, Rizal.

CABANOS, JUAN B.
Technical Employee, Division of Plant Industry, Bureau of Agriculture, Manila.

COLLADO, ESTEBAN, B.S.A., M.S. (Univ. Phil.)
Instructor in Chemistry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

DARIO, LEONCIO
In Charge, Barili Experiment Station, Bureau of Agriculture, Barili, Cebu.

DAVID, PEDRO, B.S.A. (Univ. Phil.)
Instructor in Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna.

ESGUERRA, JOSÉ P., B.S.A. (Univ. Phil.)
Animal Husbandman, College of Agriculture, University of the Philippines, Los Baños, Laguna.

FRONDA, FRANCISCO M., Ph.D. (Cornell Univ.)
Instructor in Animal Husbandry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

GONZALEZ, JOAQUIN
Farmer, Apalit, Pampanga.

HARDER, TOMAS
Farm Adviser, Bureau of Agriculture, Capiz, Capiz.

HERNANDEZ, NEMESIO
Technical Employee, Damao Experiment Station, Bureau of Agriculture, Damao, Isabela.

HIDALGO, VICENTE
Technical Employee, Alabang Stock Farm, Bureau of Agriculture, Alabang, Rizal.

LAGO, FRANCISCO P., B.S.A. (Univ. Phil.)
Animal Husbandman, College of Agriculture, University of the Philippines, Los Baños, Laguna.

LEAÑO, BENEDICTO C.
Technical Employee, Lamao Experiment Station, Bureau of Agriculture, Limay, Bataan.

LINDAYAG, GASPAR
Deceased.

LIPAYON, ANASTASIO
Student, University of California, Berkeley, California.

MANIO, MELECIO
Farm Adviser, Bureau of Agriculture, Dansalan, Lanao.

NARABAL, TIBURCIO
Farm Adviser, Bureau of Agriculture, Cagayan, Misamis.

NISCE, TEOFILO
Technical Employee, Fiber Division, Bureau of Agriculture, Manila.

NOGUERRA, JOSÉ
In Charge, Batangas Experiment Station, Batangas, Batangas.

PADOLINA, FELIPE
Technical Employee, Tanawan Experiment Station, Bureau of Agriculture, Tanawan, Batangas.

[1] College of Liberal Arts.

PERALTA, FERNANDO DE, B.S.A., M.S. (Univ. Phil.)
Assistant in Plant Physiology, College of Agriculture, University of the Philippines, Los Baños, Laguna.

RED, FRANCISCO R.
Farm Adviser, Bureau of Agriculture, Albay, Albay.

ROLDAN, EMILIANO, B.S.A., M.S. (Univ. Phil.)
Assistant in Plant Pathology, College of Agriculture, University of the Philippines, Los Baños, Laguna.

SABADO, RAYMUNDO, B.S.A. (Univ. Phil.)
Teacher, La Union Provincial High School, Bureau of Education, San Fernando, La Union.

SERRANO, FELICISIMO
Assistant Plant Pathologist, Bureau of Agriculture, Manila.

SULIT, VICTOR, B.S.A., M.S. (Univ. Phil.)
Instructor in Chemistry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

TORRES, JUAN
Student in the United States; Pensionado, Bureau of Agriculture.

VILLADOLID, DEOGRACIAS V., B.S.A., M.S. (Univ. Phil.)
Assistant in Entomology, College of Agriculture, University of the Philippines, Los Baños, Laguna.

YAP, GERMAN
Teacher, Bohol Provincial High School, Bureau of Education, Tagbilaran, Bohol.

ERESE, VALENTIN,
Deceased.

CLASS OF 1920

Master of Science

ALDABA, VICENTE C.
See Class of 1915, Bachelor of Science in Agriculture, supra.

MEDALLA, MARIANO
See Class of 1917, Bachelor of Science in Agriculture, supra.

OCFEMIA, GERARDO O.
See Class of 1915, Bachelor of Agriculture, supra.

VISTA, TOMAS I.
See Class of 1915, Bachelor of Agriculture, supra.

Bachelor of Science in Agriculture

DERECHO, ANTONIO
Farm Adviser, Bureau of Agriculture, Cebu, Cebu.

GUZMAN, ISIDORO
Farmer, Cabagan, Isabela.

JURADO, MARIANO
Technical Employee, Bureau of Agriculture, Manila.

MANIO, RAMON V.
Farmer, San Marcos, Bulacan.

PADLAN, POLICARPO
Technical Employee, Lipa Experiment Station, Bureau of Agriculture, Lipa, Batangas.

PANGANIBAN, SIMEON
Farmer, Lipa, Batangas

PAULINO, PEDRO
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REYES, GAUDENCIO M.
Assistant Plant Pathologist, Bureau of Agriculture, Manila.

Bachelor of Agriculture

AFRICA, ANGEL, B.S.A., M.S. (Univ. Phil.)
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CARANDANG, ATANACIO T., B.S.A. (Univ. Phil.)
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CATALAN, NEMESIO A., B.S.A. (Univ. Phil.)
First Lieutenant, Philippine Scouts, United States Army; Instructor in Military Science, College of Agriculture, University of the Philippines, Los Baños, Laguna.

CAZEÑAS, GREGORIO D.
Teacher, Antique Provincial High School, San Fernando de Buenavista, Antique.

CLARA, FELICIANO H.
Assistant Pathologist, Bureau of Science, Manilá.

COLLADO, ISIDORO R.
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CORRALES, JOSÉ P.
Farmer, Mambajao, Misamis.

ELAYDA, ANIANO R.
Technical Employee, Lamao Experiment Station, Bureau of Agriculture, Limay, Bataan.

ESGUERRA, JUAN
Farm Adviser, Bureau of Agriculture, Bayombong, Nueva Ecija.

ESTALILLA, HILARION H.
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FESTIN, SIMPLICIO A.
Farmer, Odioñgan, Romblon.

GOSECO, ANDRES P.
Manager, Ganadería Filipina, Guagua, Pampanga.

ISIDRO, RUFINO
Technical Employee, Bureau of Agriculture, Manila

JAMIAS, JULIO M.
Teacher, Bureau of Education, Sanchez Mira, Cagayan.

LABRADOR, ANSELMO F.
Technical Employee, La Carlota Experiment Station,
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LIMBO, ANASTASIO
Technical Employee, Bureau of Agriculture, Malabalay, Bukidnon.

LIZASO, JUAN G.
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MACEDA, FELIX
Farm Adviser, Bureau of Agriculture, Tagbilaran, Bohol.

MANGONON, ALEJANDRO S.
Residence in the United States; occupation unknown.

MARIANO, SEVERO J.
Student in the United States.

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MORADA, EMILIO K
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PALAFOX, SERAPIO M
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Bureau of Agriculture, La Carlota, Occidental Negros.

PUGEDA, MELQUIADES S.
Farmer, Rosario, Cavite.

RAMOS, FLORENTINO
Deceased.

ROSALES, PEDRO S.
Farmer, Indang, Cavite.

TOMANENG, ROMAN C.
Teacher, Jaro Industrial School, Jaro, Iloilo.

VILLANUEVA, CRISPIN B.
Technical Employee, Cotabato Experiment Station, Cotabato, Cotabato.

VILLANUEVA, LEON B.
Deceased.

VILLARAZA, MARIANO F.
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CLASS OF 1921

Master of Science

PAÑGANIBAN, ELIAS H.
See Class of 1915, Bachelor of Agriculture, supra.

VIBAR, TORIBIO N.
See Class of 1912, Bachelor of Agriculture, supra.

Bachelor of Science in Agriculture (*Supplementary*)

CATALAN, NEMESIO A.
See Class of 1920, Bachelor of Agriculture, supra.

PAÑGANIBAN, ELIAS H.
See Class of 1915, Bachelor of Agriculture, supra.

VIBAR, TORIBIO N.
See Class of 1912, Bachelor of Agriculture, supra.

Bachelor of Science in Agriculture

ALLAS, TEOFILO B.
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CHANDRASTITYA, IANG
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MIÑANO, GERONIMO M.
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PEREIRA, EUFEMIANO DE BRAGANZA
Goa, Portuguese India, occupation unknown

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ABESAMIS, AMBROSIO
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LACSON, PRUDENCIO S.
Teacher, Bureau of Education, Manila.
MANZA, ARTEMIO V., B.S.A. (Univ. Phil.)
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MARQUEZ, SEVERO L.
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NERIC, JUAN I.
Occupation unknown; residence unknown.
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REYES, ANTONIO S., B.S.A. (Univ. Phil.)
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REYES, RUFO
Farmer, Siniloan, Laguna.
REYES, TEODORICO P., B.S.A. (Univ. Phil.)
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SALINAS, LEONARDO
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SOLIVEN, FLORENCIO A., B.S.A. (Univ. Phil.)
Assistant in Chemistry, College of Agriculture, University of the Philippines, Los Baños, Laguna.
UNITE, JUAN O., B.S.A. (Univ. Phil.)
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URETA, ELIGIO C., B.S.A. (Univ. Phil.)
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CLASS OF 1922

Master of Science

HABALUYAS, RAMON K.
See Class of 1919, Bachelor of Science in Agriculture, supra.

Bachelor of Science in Agriculture (Supplementary)

AFRICA, ANGEL A.
See Class of 1920, Bachelor of Agriculture, supra.
CAPINPIN, JOSÉ M.
See Class of 1920, Bachelor of Agriculture, supra.
CARANDANG, ATANACIO T.
See Class of 1920, Bachelor of Agriculture, supra.
COLLADO, ESTEBAN G.
See Class of 1919, Bachelor of Agriculture, supra.
DAVID, PEDRO A.
See Class of 1919, Bachelor of Agriculture, supra.
DAWIS, VICENTE M.
See Class of 1916, Bachelor of Agriculture, supra.
ESGUERRA, JOSÉ P.
See Class of 1919, Bachelor of Agriculture, supra.
LAGO, FRANCISCO P.
See Class of 1919, Bachelor of Agriculture, supra.

PERALTA, FERNANDO DE
See Class of 1919, Bachelor of Agriculture, supra.

ROLDAN, EMILIANO F.
See Class of 1919, Bachelor of Agriculture, supra.

SABADO, RAYMUNDO A.
See Class of 1919, Bachelor of Agriculture, supra.

SULIT, VICTOR S.
See Class of 1919, Bachelor of Agriculture, supra.

VILLADOLID, DEOGRACIAS V.
See Class of 1919, Bachelor of Agriculture, supra.

Bachelor of Science in Agriculture

BABAO, SANTIAGO
Farmer, Batangas, Batangas.

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MAGGAY, HILARIO T.
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RAYOS, CATALINO
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SANCHEZ, ANTONIO G.
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SANTOS, SEVERINO R
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Bachelor of Agriculture

ABRAJANO, QUIRICO F., B.S.A. (Univ. Phil.)
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ALMAZAN, PASCUAL A.
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AQUINO, SEVERINO S.
Farmer, San Carlos, Pangasinan.

BACOL, SIMEON D.
Teacher, Bohol Provincial High School, Bureau of Education, Tagbilaran, Bohol.

BAGUI, CRISPULO G.
Farmer, Batangas, Batangas.

BUENAVENTURA, AGAPITO E.
Teacher, Catarman Agricultural School, Bureau of Education, Catarman, Samar.

COLLADO, TOMAS, B.S.A. (Univ. Phil.)
Technical Employee, Calamba Sugar Estate, Canlubang, Laguna.

CORCINO, BALTAZAR A.
Occupation unknown; residence unknown.

CUITIONG, RUFINO
Deceased.

DADUFALZA, TOMAS D., B.S.A. (Univ. Phil.)
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ESGUERRA, FELIX M., B.S.A (Univ. Phil.)
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ESTIOKO, ROMAN P.
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ESTRADA, ALBERTO A., B.S.A. (Univ. Phil.)
Occupation unknown; residence unknown.

FRIGILLANA, GENEROSO R.
Teacher, San Carlos Farm School, Bureau of Education, San Carlos, Pangasinan.

[1] College of Liberal Arts.

HERNAIS, PEDRO R.
Teacher, Bureau of Education.

HERNANDEZ, BASILIO, B.S.A. (Univ. Phil.)
Librarian, College of Agriculture, University of the Philippines, Los Baños, Laguna.

LASERNA, ERNEDO T., B.S.A. (Univ. Phil.)
Occupation unknown; residence, Santa Rosa, Laguna.

MAGSINO, JUAN R.
Teacher, Bureau of Education, Manila.

MARILAO, VENERANDO P.
Technical Employee, Philippine Sugar Centrals Agency, Pulupandan, Occidental Negros.

MENDOZA, FRANCISCO M.
Technical Employee, Isabela Sugar Central, Isabela, Occidental Negros.

MONCERATE, BENITO N.
Farmer, San Joaquin, Iloilo.

NOVERO, TEOFILO F.
Assistant in Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna.

PADILLA, BONIFACIO
Teacher, Central Luzon Agricultural School, Muñoz, Nueva Ecija

PELIÑO, ANACLETO R.
Teacher, Manila City Schools, Manila.

PEÑA, DANIEL B., B.S.A. (Univ. Phil.)
Assistant in Animal Husbandry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

PIGUING, RAFAEL M., B.S.A. (Univ. Phil.)
Assistant in Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna.

PONCE, BASILIO F.
Teacher, Bureau of Education, Manila.

PULGAR, GERMAN M.
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PUNZALAN, EDILBERTO S.
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ROCAFORT, ANTONIO L., B.S.A. (Univ. Phil.)
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RODIS, FILOTEO B., B.S.A. (Univ. Phil.)
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SAGUN, CASAMIRO B. DE, B.S.A. (Univ. Phil.)
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SARMIENTO, VALERIANO M.
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VIADO, BASILIO O.
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CLASS OF 1923

Master Farmer

CRUZ, FLORENTINO F.
See Class of 1916, Bachelor of Agriculture, supra.

FRANCISCO, GREGORIO
See Class of 1917, Bachelor of Science in Agriculture, supra.

Master of Science

AFRICA, ANGEL A.
See Class of 1920, Bachelor of Agriculture, supra.

CAPINPIN, JOSÉ M.
See Class of 1920, Bachelor of Agriculture, supra.

COLLADO, ESTEBAN G.
See Class of 1919, Bachelor of Agriculture, supra.

GONZALEZ, LEON G.
See Class of 1922, Bachelor of Science in Agriculture, supra.
PERALTA, FERNANDO L. DE
See Class of 1919, Bachelor of Agriculture, supra.
ROLDAN, EMILIANO F.
See Class of 1919, Bachelor of Agriculture, supra.
SULIT, VICTOR S.
See Class of 1919, Bachelor of Agriculture, supra.
TALEON, ALEJO T.
See Class of 1921, Bachelor of Science in Agriculture, supra
VILLADOLID, DEOGRACIAS V.
See Class of 1919, Bachelor of Agriculture, supra.

Bachelor of Science in Agriculture (Supplementary)

ABRAJANO, QUIRICO F.
See Class of 1922, Bachelor of Agriculture, supra.
AGATI, JULIAN A.
See Class of 1921, Bachelor of Agriculture, supra.
AQUINO, DIONISIO I.
See Class of 1921, Bachelor of Agriculture, supra.
BERNARDO, FRANCISCO R.
See Class of 1921, Bachelor of Agriculture, supra.
CARAY, ELIAS M
See Class of 1921, Bachelor of Agriculture, supra.
CENDAÑA, SILVERIO M.
See Class of 1921, Bachelor of Agriculture, supra
ESTRADA, ALBERTO A
See Class of 1922, Bachelor of Agriculture, supra.
DADUFALZA, TOMAS D.
See Class of 1922, Bachelor of Agriculture, supra.
GOCO, LORENZO L.
See Class of 1922, Bachelor of Agriculture, supra.
JIMENEZ, ALEJO L.
See Class of 1921, Bachelor of Agriculture, supra.
LASERNA, ERNEDO T.
See Class of 1922, Bachelor of Agriculture, supra.
LONTOK, GREGORIO B.
See Class of 1920, Bachelor of Agriculture, supra.
MANZA, ARTEMIO V.
See Class of 1921, Bachelor of Agriculture, supra.
PEÑA, DANIEL B.
See Class of 1922, Bachelor of Agriculture, supra.
PIGUING, RAFAEL M.
See Class of 1922, Bachelor of Agriculture, supra.
REYES, ANTONIO S.
See Class of 1921, Bachelor of Agriculture, supra.
REYES, TEODORICO
See Class of 1921, Bachelor of Agriculture, supra.
RODIS, FILOTEO B.
See Class of 1922, Bachelor of Agriculture, supra.
RODRIGO, PEDRO A.
See Class of 1921, Bachelor of Agriculture, supra.
SAGUN, CASIMIRO B. DE
See Class of 1922, Bachelor of Agriculture, supra.
SOLIVEN, FLORENCIO A.
See Class of 1921, Bachelor of Agriculture, supra.
UNITE, JUAN O.
See Class of 1921, Bachelor of Agriculture, supra.
URETA, ELIGIO C.
See Class of 1921, Bachelor of Agriculture, supra.

Bachelor of Science in Agriculture

ANTENOR-CRUZ, GREGORIO J.
Technical Employee, Hacienda Filomena, Isabela, Occidental Negros.

AQUINO, EMILIO CABREZA
Farmer, Pagsanjan, Laguna.

BENGSON, ARTURO
Student, College of Law, University of the Philippines, Manila.

CELIS, EUGENIO D.
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CRISANTO, JOSÉ
Teacher, Manila North High School, Bureau of Education, Manila.

CRUZ, SEGUNDO MANUEL
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JAOJOCO, FELIPE M.
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JULIANO, JOSÉ B.
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LEONCIO, MARTIN O.
Assistant in Chemistry, College of Liberal Arts, University of the Philippines, Manila.

MABBUN, PABLO N.
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OLOFERNES, BERNABE AGERO
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SADORRA, NAZARIO M.
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TALENTO, APOLINAR S.
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TERUEL, EUSEBIO TALEON
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ZAMUCO, CALIXTO T.
Occupation unknown; residence, Aguilar, Pangasinan.

Bachelor of Agriculture

ACUÑA, EULOGIO M.
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CARREON, FELIX D.
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FLORES, GERONIMO L.
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GAVARRA, PERPETUO A.
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LOMIBAO, PATRICIO
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LOPEZ, ENRIQUE
Farmer, Quingua, Bulacan.

MALABANAN, PEDRO L.
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PAGLINAWAN, SERGIO B.
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PAGSOLINGAN, JUAN G.
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REVECHE, FELICIANO R.
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RODRIGUEZ, AGUSTIN Y.
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SAN JOSE, PRIMO C.
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SAN JUAN, JOSE MAÑALAC
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TENEBRO, MAGNO T.
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CLASS OF 1924 -(Ad interim)

Bachelor of Science in Agriculture (Supplementary)

HERNANDEZ, BASILIO
See Class of 1922, Bachelor of Agriculture, supra.

ROCAFORT, ANTONIO L.
See Class of 1922, Bachelor of Agriculture, supra.

PUBLISHED CONTRIBUTIONS FROM THE COLLEGE OF AGRICULTURE

I: TECHNICAL CONTRIBUTIONS 1909 1918.[1]

(1) COPELAND, E. B. The ferns of the Malay-Asiatic region, Part I. Philippine Journal of Science **4C**: 1-66 *Pl. 1-21.* 1909.

(2) COPELAND, E. B. New or interesting Philippine ferns, IV Philippine Journal of Science **4C**: 111-116. 1909.

(3) COPELAND, E. B. Additions to the Bornean fern flora. Philippine Journal of Science **5C**: 283-286. 1910.

(4) COPELAND, E. B Papuan ferns collected by the Reverend Copland King. Philippine Journal of Science **6C**: 65-92. 1911

(5) COPELAND, E. B. Bornean ferns collected by C J Brooks Philippine Journal of Science **6C**: 133-144. *Pl 1-14.* 1911.

(6) COPELAND, E. B. New or interesting Philippine ferns, V Philippine Journal of Science **6C**: 145-148. 1911.

(7) COPELAND, E B Cyatheae species novae orientales. Philippine Journal of Science **6C**: 359-364. 1911

(8) FRANCO, FELIX Rice growing in Pampanga. Philippine Agriculturist and Forester **1**: 7-8. 1911.

(9) ZAMORA, JOSÉ. Leptocorisa acuta. Philippine Agriculturist and Forester **1**: 8-9 1911

(10) ROXAS, M. The pandan industry in Majayjay Philippine Agriculturist and Forester **1**: 11-12. 1911

(11) DURHAM, S. B. Some practical advice on horse breeding in the Philippines. Philippine Agriculturist and Forester **1**: 13-14. 1911.

(12) COPELAND, E. B. Maniok varieties. Philippine Agriculturist and Forester **1**: 22 1911.

(13) COPELAND, E. B. Root crops. Philippine Agriculturist and Forester **1**: 23 *Pl 1-6* 1911.

(14) COPELAND, E. B. Taal and agriculture. Philippine Agriculturist and Forester **1**: 24-26. 1911.

(15) NAVARRO, ANDRES F. Some local insects of economic importance. Philippine Agriculturist and Forester **1**: 32-35. *Pl. 1-2.* 1911.

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[1] The list was prepared by the Registrar, College of Agriculture, (Registrar's Circular No 41, s 1923-1924), and contains the technical contributions of the faculty and students of the College published prior to the establishment, in 1919, of the Experiment Station. The contributions are numbered serially as reported

(16) VIBAR, T. N. The establishment of a vegetable garden. Philippine Agriculturist and Forester 1: 38-39. *Pl. 1.* 1911.

(17) COPELAND, E. B. Caiñgins. Philippine Agriculturist and Forester 1: 43. *Pl. 1.* 1911.

(18) COPELAND, E. B. Physiology of the coconut. Philippine Agriculturist and Forester 1: 44-50. 1911.

(19) CRUZ, MARIANO MANAS. Live stock farming and soils. Philippine Agriculturist and Forester 1: 54-55. 1911.

(20) ROXAS, MANUEL. The cultivation of coconut. Philippine Agriculturist and Forester 1: 57-60. 1911.

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THE VITAMIN B CONTENT OF SOME PHILIPPINE FRUITS AND VEGETABLES[1]

By Eulogio M Acuña

INTRODUCTION

It is generally recognized that plants form the best source of certain dietary essentials which we now call the vitamins. In the Philippines, fruits and vegetables abound all the year round and for this reason people are inclined to think that little attention need be paid to the problem of procuring diets which will furnish these essentials. "This, however, is not invariably the case" (1). In spite of the availability of fruits and vegetables all the year round, deficiency diseases have occurred and are occurring among the Filipino people.

At present the chemistry laboratory in this College is engaged in a systematic study of the nutrition of the Filipino people and for this reason "it becomes highly desirable that vitamin tests be made on the fruits and vegetables which are being or may be eaten by them" (1).

Probably the first systematic investigation of the vitamin content of Philippine food materials was made by Santos (1) who determined the vitamin B content of *togi* (sprouted mungo), okra, avocado, mango, sweet potato leaves, duhat (*Eugenia jambolana* L.), artichokes, bilimbi (*Averrhoa carambola* L.), banana flower bud, and bamboo shoots. He also showed that the vitamin C in *togi* is destroyed in the culinary preparation. Embrey (2) recently determined the presence of vitamin C in pummelo, cucumber, chico, guava, banana, lanzon, cankong (*Ipomœa reptans* (L.) Poir) and camote (sweet potato) leaves.

Johns, Finks, and Paul (3) found copra meal to be rich in vitamin B and somewhat deficient in vitamin A; and Derecho (4) found it to be poor in vitamin C. Recently it has been suggested that copra meal be used by the Filipinos as source of protein, but in the light of the findings in this laboratory (unpublished) we hesitate to recommend that this suggestion be followed. It is thus seen that only a very limited number of Philippine fruits and vegetables has been examined for their vitamin content.

It was the object of this investigation to determine the comparative vitamin B content of some Philippine fruits and vegetables not yet studied.

The present work was carried out in the College of Agriculture, Los Baños, for a period of about seven months beginning in August, 1923.

MATERIALS AND METHODS

Thus far the only method known for the determination of the presence of vitamin is biological and this is the method used in the present investigation.

White rats were used as the experimental animals. They were grouped into pairs (a male and a female) of about the same age. Each animal was kept in a separate cage, but once a week each pair was put together for at least five hours to enable them to breed. The animals were weighed once a week.

[1]Thesis presented for graduation from the College of Agriculture, No 162; Experiment Station contribution No. 197. Prepared in the Department of Chemistry under the direction of Dr. Manuel L. Roxas and Dr F. O. Santos.

THE FEED

The experimental diet consisted of a basal ration plus the vegetable or fruit as supplement. Water extract of egg yolk was used as control source of vitamin B.

Basal ration.—The basal ration had the following composition:

Polished rice	69
Casein (washed)	15
Butter fat	10
Salt mixture (McCollum and Davis) (5)	4
Filter paper	2

The polished rice was ground fine; the casein was washed thoroughly with water, at least five times, and then ground. The filter paper was first macerated, then pressed and dried. In the course of drying the small pieces were separated. Butter fat from high quality butter was used. The salt mixture was prepared according to McCollum and Davis) (5):

Sodium chloride	5 00	grams
Dipotassium phosphate	12 10	"
Primary calcium phosphate-monohydrate	2.56	"
Calcium lactate	29 44	"
Iron citrate	1.00	"

Supplements.—The fruits tested for vitamin B were the following;

Banana, *Musa sapientum*
Papaya, *Carica papaya*
Paayap, *Vigna sinensis*

The fruits were analysed for proximate composition at the Experiment Station Food Laboratory and the results are shown in the following tabulation:

	Moisture	Fat.	Ash	Protein.	Crude fiber.	Carbohydrates.
Paayap.	89 59	0 37	0 21	3 06	1 64	5 13
Banana.	72 14	0 48	0 84	0 97	0 51	25 06
Papaya	87 72	5 16	0 53	0 23	2 68	3 59

In preparing the food mixture, the required amount of the supplements was weighed fresh and then mixed with the basal ration just before feeding.

Control source of vitamin B.—Yolk of hard boiled egg was macerated with from 30 to 60 per cent alcohol, stirred for about twenty minutes and allowed to settle. The supernatant liquid was separated and distilled until all the alcohol was removed. Then it was evaporated on a water bath to the desired concentration, that is, when the resulting liquid would hardly flow on inclining the container.

The feed was weighed daily. Unless otherwise specified the animals were given boiled water *ad libitum*.

EXPERIMENTAL

CONTROL FEEDING

To determine that the basal ration prepared as described above is really deficient in vitamin B, a pair (155 ♀ and 135 ♂) was given this ration alone. The animals decreased in weight. Then water extract from one-half gram of egg yolk was given daily to each animal in addition to the basal ration. The extract was diluted with water and the calculated amount of basal ration which a rat took daily was moistened with it. On this improved ration Rat No. 135 ♂ recovered part of its weight; when the supplement was increased to two grams daily complete recovery ensued. Rat No. 155 ♀ on one-half gram supplement showed great increase in weight; but later decreased and then again increased when the supplement was made two grams daily. The animals' food intake was very low with the basal ration alone, but with the supplement their appetite improved decidedly.

TEST FOR VITAMIN B

Papaya.—Three pairs of rats were given the basal ration plus fresh papaya in doses of 10, 20, and 40 grams. These amounts were used following the results of preliminary trials in which several pairs were given varying amounts of papaya. It was found that 40 grams of this fruit was the largest quantity that a rat would take daily with the basal ration.

10-gram supplement.—From August 13 to September 12, Rats 130 ♂ and 123 ♀ were given 1 gram papaya as daily supplement. On September 13 the supplement was increased to 2 grams; on September 23, to 4 grams; on September 27, to 5 grams; on September 30, to 6 grams; on October 30, to 7½ grams; and finally to 10 grams from November 27 to February 18.

On a supplement of 1 gram daily, Rat 130 ♂ decreased rapidly in weight. It recovered gradually when the supplement was successively increased to 2, 4, 5, 6, and 7½ grams. But even when the supplement was increased to 10 grams the rat was not able to recover its original weight though it was kept on the last supplementary dose for 3 months.

Rat 123 ♀, also decreased in weight when given only 1 gram of the fruit a day as supplement, but gradually improved when the supplement was increased to 2, 4, 5, 6, and 7½ grams. When the supplement was increased to 10 grams it gained a little above its initial weight.

20-gram supplement.—At the beginning of the experiment Rats 124 ♂ and 99 ♀ received 4 grams of papaya as daily supplement. On September 12, this was increased to 5 grams; on September 23, to 8 grams; on September 27, to 10 grams; on September 30, to 12½ grams; and on October 5, to 15 grams. Finally the supplement was increased to 20 grams on November 27. This last supplementary dose was given until February 18.

Rat 124 ♂ on the varying amount of supplement mentioned at first decreased in weight and then later took on more than its original weight. On the same supplementary dose Rat 99 ♀ also declined at first and then recovered.

40-gram supplement.—Rats 125 ♂ and 100 ♀ were given papaya as supplement in varying amounts and on the same dates, but the amounts were twice those given to Rats 124 ♂ and 99 ♀. Both animals increased markedly in weight.

Banana.—As in the preceding experiment with papaya, fresh banana was used as supplement in varying amounts. It was found that 20 grams of this fruit was the maximum an animal would take in addition to the basal ration. So, for the 3 pairs that received banana as supplement, the amounts given were 5, 10, and 20 grams respectively.

5 grams as supplement.—From August 13 to September 2, Rats 150 ♂ and 136 ♀ were each given 1 gram of banana as daily supplement to the basal ration. On September 3 the supplement was increased to 4 grams; on September 17, to 5 grams; and on September 27, to 7½ grams. Finally, on October 9, it was reduced to 5 grams. This was given until February 18.

At first, Rat 150 ♂ decreased in weight, but when larger doses of banana were given there was a corresponding increase in weight of the animal. When the dose was again reduced to 5 grams there was a sligh decrease in weight, but this was recovered later and the rat continued to grow.

Rat 136 ♀ also decreased in weight at first and then gradually increased until the final weight was appreciably greater than the original.

10 grams of banana as supplement.—From the beginning of the experiment on August 13, pair 151 ♂ and 137 ♀ was given 5 grams of banana as daily supplement to the basal ration for each animal. On September 3 the amount was increased to 8 grams; to 10 grams on September 17; to 15 grams on September 27; and then reduced to 10 grams on October 9. This amount was given daily until February 18.

Rat 151 ♂ first decreased in weight. When larger doses of banana were given the weight showed marked increases.

Rat 137 ♀ first increased in weight, then continued decreasing even when the amount of banana given was increased. However, after a time the animal began to gain weight though in a very gradual manner.

20 grams as supplement.—From August 13 to September 2, Rats 153 ♂ and 119 ♀ each received 10 grams of banana as daily supplement to the basal ration. On September 3, 16 grams were given; 20 grams on September 17; 30 grams on September 27; and 20 grams on October 9.

Rat 153 ♂ decreased in weight until the banana given was increased to 16 grams on September 16, when it began to take on weight. The increase continued as the amount of banana given was increased; but when on October 9 the dose was reduced from 30 to 20 grams, the animal lost weight, but only for a brief period as it afterwards regained the weight lost.

Rat 119 ♀ with 10 grams of banana as supplement increased in weight at first, then declined, but took on weight again. When the supplement was increased to 16 grams, there was practically no growth, but when the dose was increased to 20 grams and later to 30 there was an increase in weight.

Paayap (*Vigna sinensis*).—The three pairs of rats that were used in this experiment previously received different rations. Rats 154 ♂ and 121 ♀ were given basal ration alone. Rats 129 ♂ and 122 ♀ were getting the basal ration plus papaya. And Rats 152 ♂ and 138 ♀ were taking the basal ration plus banana.

The paayap used was the variety most commonly eaten by the people in this locality. Care was taken to use only green and tender pods which were cut

into small pieces and then boiled. The broth was diluted with a little water and given to the animals for drinking.

Beginning on September 10 these three pairs of rats were given varying amounts of paayap as daily supplement to the basal ration. On September 23 the giving of fixed amounts of daily supplement began.

5-gram supplement.—Pair 154 ♂ and 121 ♀ had already declined in weight on the basal ration before paayap was given. After three months on the supplementary doses of paayap both animals weighed more than their initial weight at the beginning of the feeding with basal ration alone.

10-gram supplement.—Pair 129 ♂ and 122 ♀ had already declined in weight on the basal ration plus insufficient amount of papaya as supplement. When the papaya was replaced by paayap both rats increased in weight over their initial weights at the beginning of the experiment.

20-gram supplement.—Rats 138 ♂ and 152 ♀ increased greatly in weight on this supplementary dose of paayap.

DISCUSSION OF RESULTS

PAPAYA

The weekly body weights and food intake of the animals are given in Tables I to IV. The body weights are also represented graphically in Chart I.

From an examination of the chart and also of Table II, it can be seen that on a supplementary dose of 10 grams the animals were just able to maintain their weights, but when the papaya supplement was increased to 20 or 40 grams the animals greatly increased in weight. This shows that the supplementary dose of 10 grams is about enough for maintenance and that 20 and, of course, 40 grams would be sufficient for growth.

BANANA

Table III shows that all of the animals had practically the same amount of food intake and that whatever difference there was in growth was due to the banana supplement.

On the least supplementary dose of 5 grams daily the animals increased in weight over the initial. Similar increases in weight were obtained with 10 and 20 grams of banana as daily supplementary dose.

PAAYAP

The results obtained are similar to those obtained with banana, although more pronounced. All of the animals were able to increase their weight above that at the beginning of the experiment.

Compared with the same amount of banana, paayap seems to be a better source of vitamin B, for the animals fed this increased in weight faster than the animals that were given corresponding amounts of banana.

As will be noted none of the rats reproduced during the experimental period. It is not believed that these animals were really unproductive for the stock from which they were taken are still breeding and some of them had reproduced before they were used in this work. It is hardly possible to say that this lack of

fertility is due to the diet, although it is now known that the substance X (6) is necessary to fertility and the production of healthy young.[2]

SUMMARY AND CONCLUSIONS

1. Paayap was found to be a good source of vitamin B. Five grams of the boiled fresh paayap were enough to promote normal growth when used as a supplement to a standard ration deficient in vitamin B.

2. Banana also contains an appreciable amount of vitamin B. Five grams as supplement to the basal ration are not as efficient to promote growth as paayap, but 10 grams are sufficient for normal growth.

3. Papaya, likewise, contains vitamin B but in a smaller amount than either the banana or the paayap. Twenty grams of this fruit are needed as daily supplement to the basal ration to promote normal growth of the rats.

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[2] For lack of space, the animals were kept in a place adjoining an analytical laboratory at the beginning of the experiment. Hydrogen sulphide gas and acid fumes quite often invaded the room where the rats were kept. It was soon noticed that the gases were having a deteriorating effect on the animals as judged from the ragged appearance of the control which was receiving a complete diet. Upon this discovery the animals were transferred to a room far from the chemistry building when the appearance of the control improved in a very marked way. It may be possible that the action of the gases and the fumes may have had some permanent effect on the fertility of the animals.

TABLE I.—*Control: Body weight and weekly intake of basal diet.*

Feeding period 1922-1923.	135 ♂		155 ♀	
	Body weight.	Diet.	Body weight.	Diet.
	gm.	*gm.*	*gm.*	*gm.*
August 13	——	——	160	——
August 20	213	——	155	——
August 27	194	——	150	——
September 3	160	10	140	20
September 10	136	20	118	10
September 17	107x	10	112x	20
September 24	123	40	130	50
October 1	129	57	150	84
October 8	150	76	175	118
October 15	162	79	182	79
October 22	167	79	185	69
October 29	173	60	191	55
November 5	179	60	182	58
November 12	175	50	180	72
November 19	170	50	176	44
November 26	156	57	164	47
December 3	153	60	167	62
December 10	159	72	176	84
December 17	159	70	177	66
December 24	176	70	185	76
December 31	170	82	180	78
January 7	170	78	175	78
January 14	160	74	172	72
January 21	160	45	165	45
January 28	131y	25	161y	55
February 4	175	84	194	93
February 11	204	123	208	100
February 18	221	96	213	101

NOTE.—*Key to tables:*

x = extract of one-half gram of egg yolk was given as supplement.
y = extract of two grams of egg yolk was given as supplement.
v = fixed amount of supplement was given

TABLE II.—*Papaya: Body weight and weekly intake of basal diet.*

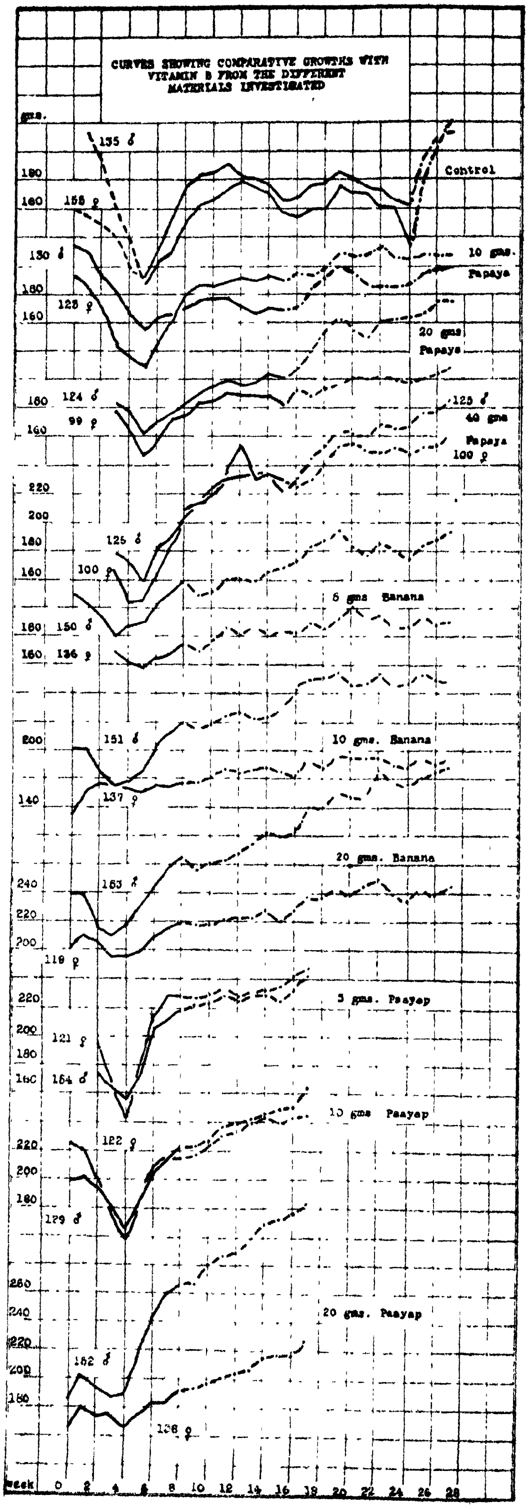
Feeding period 1922-23.	10 gram supplement.				20 gram supplement.				40 gram supplement.			
	130 ♂		123 ♀		124 ♂		99 ♀		125 ♂		100 ♀	
	Body weight.	Diet.	Body weight.	Diet.	Body weight.	Diet.	Body weight.	Diet.	Body weight.	Diet.	Body weight.	Diet.
	gm.	*gm.*	*gm.*	*gm*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*
August 13	215	—	195	—	—	—	—	—	—	—	—	—
August 20	210	—	185	—	—	—	—	—	—	—	—	—
August 27	192	—	170	—	—	—	—	—	—	—	—	—
September 3	180	20	143	10	183	20	177	20	180	50	167	32
September 10	164	30	134	25	178	30	164	25	172	40	146	15
September 17	155	35	128	30	162	30	147	30	159	55	146	55
September 24	163	58	147	70	170	54	157	26	184	70	163	55
October 1.	165	65	163	80	176	56	172	70	190	80	188	100
October 8.	171	65	179	100	183	55	175	90	205	70	208	110
October 15.	175	65	185	65	190	55	184	65	214	70	215	80
October 22.	176	60	185	63	196	62	185	57	225	77	225	75
October 29	176	53	188	60	199	60	191	50	231	75	238	63
November 5.	171	47	191	47	197	55	189	50	233	65	254	70
November 12	166	60	189	58	198	71	188	56	234	69	232	65
November 19	169	50	192	50	204	57	188	43	234	57	235	70
November 26	168v	57	189v	55	201v	59	183v	50	222v	66	230v	52
December 3.	170	34	194	70	207	60	193	45	232	70	225	55
December 10	183	75	192	60	221	80	189	49	245	93	229	55
December 17.	191	72	198	72	235	85	194	60	254	94	243	75
December 24.	199	80	208	69	242	74	197	69	264	80	254	85
December 31	194	50	206	62	235	69	202	59	262	75	256	78
January 7	186	71	207	76	231	78	201	69	261	65	251	61
January 14	184	69	213	71	241	86	203	67	270	86	250	45
January 21	184	69	205	65	242	89	200	65	267	85	253	70
January 28	185	74	204	60	244	94	199	60	268	86	249	75
February 4	194	73	207	65	247	85	201	55	277	60	253	40
February 11	196	75	207	70	255	75	205	60	278	70	254	55
February 18	198	70	207	65	255	80	209	60	286	59	265	65

TABLE III.—*Banana: Body weight and weekly intake of basal diet.*

Feeding period 1922-23.	5 gram supplement.				10 gram supplement.				20 gram supplement.			
	150 ♂		136 ♀		151 ♂		137 ♀		153 ♂		119 ♀	
	Body weight.	Diet.	Body weight.	Diet.	Body weight	Diet.	Body weight.	Diet.	Body weight.	Diet.	Body weight.	Diet
	gm.	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm*	*gm.*	*gm.*	*gm.*	*gm.*
August 13.	210	—	—	—	201	—	135	—	239	—	200	—
August 20.	202	—	—	—	200	—	151	—	238	—	210	—
August 27.	194	—	—	—	185	—	156	—	215	—	205	—
September 3.	180	45	170	55	175	28	155	35	210	35	195	30
September 10.	187	50	162	45	178	48	152	40	217	50	195	45
September 17.	190	80	159	20	185	65	150	35	231	75	199	65
September 24.	204	73	165	50	205	81	155	65	246	67	209	56
October 1.	211	75	168	60	213	68	155	45	258	65	215	40
October 8	219v	80	175v	60	219v	79	157v	35	265v	60	219v	30
October 15	210	75	170	50	215	60	157	35	256	80	218	25
October 22	212	67	177	68	219	60	161	48	261	67	218	37
October 29	221	68	187	71	224	67	167	35	256	52	221	35
November 5	221	75	182	50	226	65	164	45	268	80	223	40
November 12	220	87	186	64	223	69	166	65	274	89	223	47
November 19.	226	69	182	43	224	54	168	40	282	60	228	43
November 26.	229	74	184	46	230	74	165	40	280	68	221	35
December 3	234	94	183	55	243	82	163	45	283	81	228	60
December 10	244	78	190	65	251	80	173	45	300	85	237	45
December 17.	248	88	186	50	252	83	168	50	300	63	238	50
December 24	256	74	193	57	258	86	176	40	311	80	244	59
December 31	243	75	201	71	247	62	175	45	308	69	240	45
January 7	238	82	194	73	248	76	175	70	308	84	245	57
January 14..	246	81	195	64	255	72	175	55	326	86	250	50
January 21	241	84	188	60	246	75	170	45	318	65	240	50
January 28	236	89	187	65	248	75	169	45	317	60	236	55
February 4.	245	71	195	55	254	58	175	45	321	57	244	34
February 11	249	90	191	50	251	70	171	50	325	75	239	50
February 18	255	80	191	50	250	65	175	45	328	70	245	50

TABLE IV. —*Paayap: Body weight and weekly intake of basal diet.*

Feeding period 1922-23.	5 gram supplement				10 gram supplement				20 gram supplement.			
	154 ♂		121 ♀		129 ♂		122 ♀		152 ♂		138 ♀	
	Body weight.	Diet	Body weight	Diet.	Body weight	Diet	Body weight	Diet	Body weight	Diet.	Body weight	Diet.
	gm.	*gm*	*gm.*	*gm*	*gm*	*gm*	*gm*	*gm.*	*gm*	*gm.*	*gm.*	*gm.*
August 13.	—	—	—	—	200	—	225	—	186	—	165	—
August 20. .	—	—	—	—	201	—	221	—	203	—	180	—
August 27. .	175	—	198	—	195	—	200	—	195	—	175	—
September 3.	165	15	167	15	180	25	172	15	189	40	176	40
September 10. .	156	35	143	10	163	25	159	15	190	45	167	40
September 17.. ..	173	90	178	70	183	85	179	55	216	80	176	65
September 24....	206	135	212	135	205	110	209	140	243	110	184	89
October 1....	212	92	228	115	214	75	215	95	260	116	184	70
October 8.. .. .	218v	85	228v	95	223v	85	215v	65	267v	100	192v	65
October 15.... .	222	90	227	80	223	75	217	75	267	85	194	75
October 22... ..	223	84	230	76	228	84	225	86	281	84	198	71
October 29.	228	80	233	60	238	75	231	80	288	82	201	60
November 5 .	226	82	227	65	240	75	233	70	290	85	205	72
November 12. ...	229	86	228	69	243	86	240	85	299	102	208	76
November 19.. ...	229	77	232	70	246	72	245	77	309	83	216	62
November 26. .	225	72	235	70	250	74	240	65	313	79	218	60
December 3........	234	94	242	83	250	80	244	65	317	103	218	59
December 10.......	243	100	246	73	265	90	246	70	334	105	228	79



KEY TO CHART

- - - - - - - =growth on basal diet alone

——————— =growth on basal diet plus vitamin supplement in varying amount

—·—·—·— =growth on basal diet plus fixed amount of vitamin supplement

A DESCRIPTION OF A FOUR-LEGGED CHICK[1]

By Manuel D. Sumulong

Of the College of Veterinary Science

WITH TWO PLATES

While examples of various types of malformations of the extremities in mammals, ranging from total or partial lack of members to supernumerary limbs and digits, are on record, yet, so far as I am aware, there has not been a case recorded in the fowls analogous to the specimen here described. The presence of supernumerary legs in fowls, though not an unusual occurrence, especially in the chickens, is rare enough to make it of some interest, from the anatomical point of view at least.

The specimen that is the subject of the following account was given to the writer by Mr. Deogracias Villadolid of the Department of Zoology and Entomology, College of Agriculture. Judging from the size of the animal and character of the feathers it must have lived for about three weeks.

With reference to the anatomical peculiarities this chick monster closely resembles the six-legged dog described by Horseley (1) and the six-legged rat described by Conrow (2).

In the study of this chick monster the following authors were consulted: Wilder (3); Tannreuter (4); Mitchell (5); Mall (6); Alsop (7); Parker (8); Hargitt (9); Lillie (10); Bailey and Miller (11); Kellicott (12); Mall (13); Chauveau (14); and Adami and McCrae (15).

EXTERNAL CHARACTERS

In Plate I the right lateral aspect of the chick in its actual size after death is shown. This chick presented two extra legs, otherwise it appeared normal both in size and body conformation. The extra legs appeared as if they hung directly from the posterior part of the body, but after closer examination of the neighboring parts it was found that they were suspended from the body by means of a slender bar of bony structure which was sparsely covered with young feathers. Both legs were smaller than the corresponding normal legs and both of them were directed obliquely downward to the left. The right extra leg was deformed and very much shorter than the left component. The right first digit was absent; the rest of the digits appeared proportionally normal but showed no indication at all that they had ever been used during life.

After the removal of the feathers closer examination of the perineal region (see Plate II, fig. 1) revealed that the slender bar, which measured two and a half centimeters in length and which was directed obliquely downward to the right, represented the fused thighs of the supernumerary limbs. The proximal half of the anterior surface of the fused thighs was united to the perineal region by a fold of integument. At their proximal extremity a somewhat triangular eminence could be palpated, which upon dissection proved to be a rudimentary

[1] Experiment Station contribution No 198.

pelvis. The left component of the extra pair of legs formed an angle of about 65 degrees with the fused thighs, and stretching from its proximal half to the whole length of the fused thighs and the eminence was a fold of integument, the presence of which undoubtedly made the extension of the leg impossible.

Two ani were present, the functional and the false. The functional anus was pushed toward the right of the median line by the rudimentary pelvis, and its opening was twice as wide as that of the false anus. The latter was located just at the left side of the base of the eminence, about two thirds of a centimeter left of the vertebral axis. It was directed toward the left rather than caudad, and on probing, it proved to be unperforated.

The uropygium was also slightly displaced toward the right, and this slight displacement seemed to be due to the pressure exerted by the rudimentary pelvis.

INTERNAL FEATURES

Careful and systematic dissection proved that this chick was partly double, and the structures most concerned in the duplication were the distal part of the alimentary tract, the pelvic girdle and the legs; the rest of the structures appeared perfectly normal for a single individual. The skeletal conditions in the pelvic region are illustrated in Plate II, fig. 2. Two pelves were present, the left one being the smaller and rudimentary. The pubic bones of the rudimentary pelvis and the left sacrum were absent. The ilia fused dorsally in the median line to form a single bone, and ventro-laterally the anterior and posterior parts of their lateral border were fused with the corresponding ischial bone. The ischium, on the other hand, fused ventrally with its fellow in the median line. At the point where the ilial and ischial bones failed to fuse was a slit-like opening (one on each side) through which passed the blood vessels and nerves for the supernumerary legs. This opening on either side of the rudimentary pelvis seemed to represent the obturator foramen. The arrangement, given above, of the os coxae gave the rudimentary pelvis the appearance of a blunt cone having an opening on either side. The anterior margin of the right ilium was connected to the ventral surface of the caudal vertebrae by means of a short thin ligament, and the anterior portion of the corresponding ischium projected into the normal pelvic cavity, interposed between the two branches of the rectum which will be alluded to later. The anterior borders of the fused ilium and ischium were continued in front by means of an irregularly triangular plate of cartilage which was firmly attached to the posterior border of the left pubic and ischial bones of the normal pelvis. Bounded in front by the posterior border of the left ilium of the normal pelvis and behind by the anterior borders of the fused ilia of the rudimentary pelvis was a somewhat elliptical opening through which passed the false anus.

The femurs of the extra pair of hind limbs were fused along their whole extent to form a single bone. These fused femurs were four millimeters shorter than either of the normal femurs, being eighteen centimeters in length. They were flattened dorsoventrally and their distal extremity was twice as wide as the proximal which measured eight millimeters in its broadest part. The characteristic head and trochanters of the femur were not evident. Superiorly the fused femurs articulated with the ventral surface of the apex of the cone-like rudimentary pelvis; the joint they formed fell in the category of amphiarthrosis. The fused femurs were at right angles with the pelvis.

The right tibia was very much deformed and twisted and measured only eight millimeters in length in contrast with twenty-five millimeters of its fellow on the opposite side. The left tibia was three millimeters shorter than either of the normal ones. The right fibula was absent. The two tibial bones articulated above with the ventral side of the distal extremity of the fused femurs, each forming an immovable joint (syndesmosis). The stifle joints of the supernumerary legs were bound together by a sheath of fibrous connective tissue and integument.

Both the right and left metatarsal bones were of the same length and two millimeters shorter than the normal ones which measured twenty millimeters in length. The joints they formed with the corresponding tibial bones were also of immovable type. All the bones of the developed digits of the extra feet were apparently normal.

It is interesting to note that the supernumerary structures described above were not provided with well organized muscles; only fibrous connective tissue strands mixed with some muscle fibers could be recognized under the integument. More muscle fibers were found in the bundles of fibrous connective tissue that stretched from the perineal region to the ventral surface of the fused femurs. The tendons of the extensor and flexor muscles of the digits were fairly well developed and could be easily dissected in the region of the lower third of the metatarsal bones. This absence of well organized muscles in the extra hind legs strongly suggests that these legs, besides being non-functional, were not under the control of the animal during life.

The digestive tract and the glands associated therewith cephalad of the point where the caeca joined the rest of the intestinal tract presented no appreciable abnormality, but caudad of the caecal openings the rectum became gradually enlarged, the diameter of its broadest part being three times that of its anterior connection, the ilium. At one and a half centimeters from the junction of the caeca and the ilium the dilated rectum bifurcated into two unequal diverging branches. The left branch was the non-functional and it was only one-half the diameter of the right branch. It was three millimeters shorter than the right or functional branch, the latter being nine millimeters in length. Neither the functional nor the non-functional branch presented any appreciable distal enlargement to indicate the characteristic cloaca.

Only the right kidney and testis were present and their ducts emptied into the functional branch of the rectum; no trace of any duct could be found communicating with the non-functional branch.

The blood supply of the rudimentary pelvis and the two extra legs was derived from a small artery that arose from the caudal artery. This branch of the caudal artery pursued a course toward the left and entered the cone-like rudimentary pelvis. On reaching the level of the foramen referred to above it became divided into two principal branches, each of which passed through the foramen on the corresponding side. Both branches broke into smaller branches which ramified the legs. The left lumbosacral plexus gave rise to a small nerve which coursed backward along with the branch of the caudal artery and became distributed in the extra legs.

CONCLUSIONS

The monster chick here reported falls in the category of duplicate monsters and apparently corresponds to the dipygus type of mammalian monsters. Look-

ing at the double portion of this chick the right component appears as fully developed and normal in position, whereas the left component is very rudimentary and lies almost wholly to the left of the median line. With the anatomical data furnished by this chick it is very difficult to decide definitely whether the condition was brought about by the fusion of two originally distinct anlagen or by the splitting of the posterior part of a single anlage. However, the fact that the supernumerary structures received their blood supply from a branch of the caudal artery and their nerve supply from a nerve arising from the left lumbo-sacral plexus, and the fact that only the right kidney and testis were present, it seems that this is a case of the splitting of the caudal portion of a single anlage. The split must have occurred at the time the leg and tail buds were beginning to manifest themselves. It is very probable that the split did not occur symmetrically, and that probably would account for the absence of the left kidney and testis and for the comparatively small size of the left component.

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ILLUSTRATIONS

PLATE I

Fig. 1.—Actual size of chick after death. Showing 1, right; 2, left, supernumerary legs: 3, right, and 4, left normal legs.

PLATE II

Fig. 1.—Drawing of the hind part of the chick after the removal of feathers to illustrate the relation of the supernumerary legs to the body. 1, slender bar of bony structure; 2, triangular eminence at the proximal extremity of the bar; 3, fold of integument stretching from the proximal half of the left leg to the bar and triangular eminence; 4, functional anus; 5, non-functional or false anus; and 6, uropygium.

Fig. 2.—Drawing of the dorsal aspect of the pelvic region to show the skeletal conditions. 1, left rudimentary pelvis; 2, 2′, left and right ilia; 3, left ischium of the rudimentary pelvis; 4, foramen (obturator); 5, triangular plate of cartilage connecting the left ilium and ischium of the rudimentary pelvis and the left pubic and ischial bones of the normal pelvis; 6, opening through which passed the false anus; 7, fused femurs; 8, right tibia; 9, 9′, right and left stifle joints; 10, 10′, left and right metatarsal bones.

Fig. 3.—Drawing of the distal part of the intestinal tract showing the duplication of the distal part of the rectum. 1, rectum; 2, junction of the caeca and the ilium; 3, 3′, right and left caeca; 4, ilium; 5, left non-functional branch of the rectum; and 6, right functional branch of the rectum.

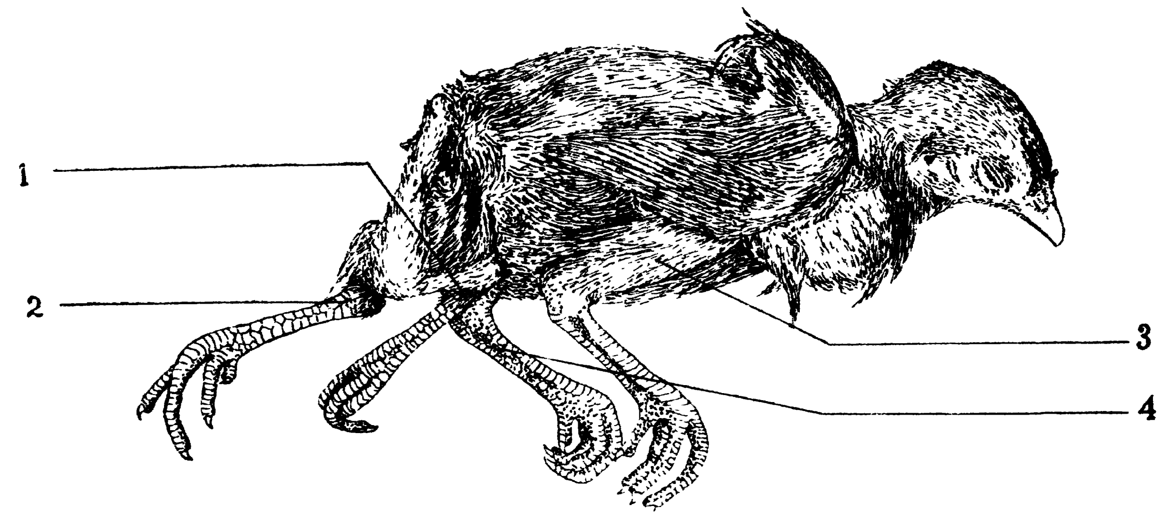

PLATE I

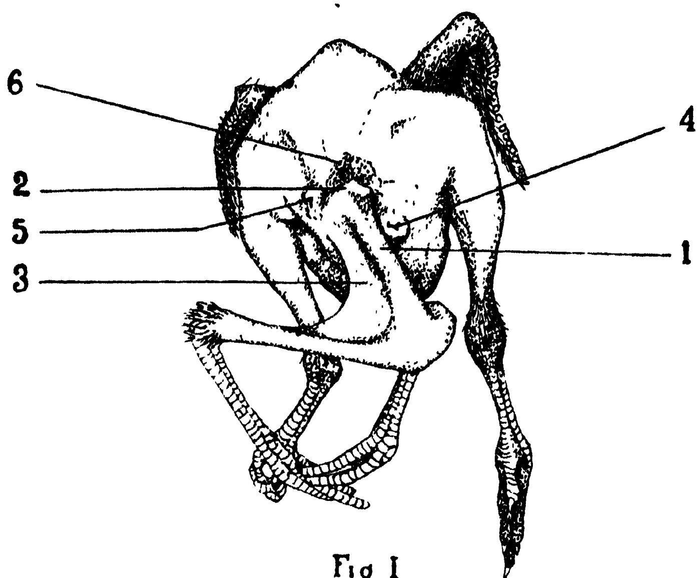

Fig I

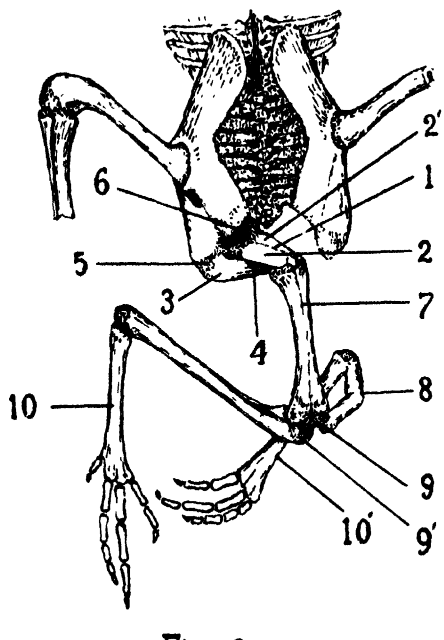

Fig 2

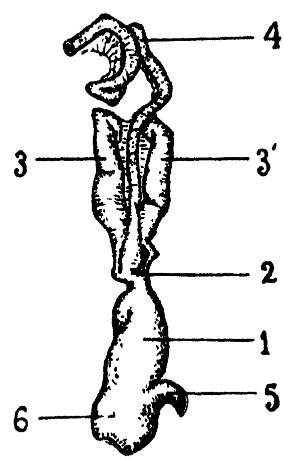

Fig 3

PLATE II

ABSTRACT[1]

An investigation on the profit and loss of the caiñgin culture, GERMAN M. PULGAR (*Thesis presented for graduation from the College of Agriculture, No. 163; Experiment Station contribution No. 199*).—*Caiñgin* culture is the most primitive method of growing rice in the Philippine Islands. The operation consists of clearing the ground and making holes in the soil in which the seeds are dropped.

This investigation was undertaken in 1920-1921 in Tanay, Rizal Province. The essential parts of the report are:

1. The *caiñgin* farmers estimate size of farms in terms of gantas (1.72 kg.) of seed planted.

2. Average yield of rough rice (*palay*) from one ganta of seed was two cavans (one cavan = 25 gantas, or 43 kg.).

3. To handle one ganta of seed and its produce requires about 63 hours of labor.

4. *Caiñgin* culture does not pay well. In the year 1920, 52 per cent, and in 1921, 80 per cent of the farms incurred losses varying from ₱0.50 to ₱114.00 while the rest made net profit ranging from ₱0.31 to ₱180.00.

5. Planting minor crops between the rice growing seasons gave better returns than growing rice alone.

Abstract by Thongdee Resanont.

[1] Abstract prepared as part of required theme work in English 101, College of Agriculture

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January, the two-faced month, is the period when we pause and look back, reflectively and inventorially, over the twelve months just completed, and forward, hopefully and perhaps adventurously, to the twelve months just ahead. This January stock-taking is a good thing for the individual, the institution, and the nation, only we are prone to use poor judgment in making valuation of the items, the events. There the difficulty lies. The events that loom large in 1923, time will show to be small. Only the sight of a seer, coupled with the wisdom of a sage, could give the events of the year just closed their proper evaluation.

It would be a fruitful study to weigh and revise in the light of present knowledge the annual published lists of notable events in any country for the past one hundred, fifty, or even twenty-five years. If, in the revision, discrimination between important and prominent events be made the revised lists would be practically new ones.

It is Huxley who comments, in speaking of the unnoted early achievements of the Royal Society, on the common and persistent error of mistaking the prominent event for the important one.

No list of outstanding events in the Philippines for 1923 has yet appeared, but it would include the usual happenings related to politics and politicians; calamities resulting from typhoons; ravages of rinderpest, anthrax, and locusts; increase of sugar output, perhaps, but not the causes—the experimental work, the better mills; conventions and parades; prominent, not always important, foreign visitors; possibly the opening of new roads, here again, the prominent, probably, and not the important, because the shorter or less heralded would not be included. The negative happenings, that is the important turned-down chance, the missed opportunity, would not be listed, of course. This is another error in our inventories.

In 2024 or 1974, in all likelihood, none of these events will have a place in Philippine history. It is reasonably certain that the year will be marked, if marked at all, by events not now recognized as worth making a note of. It may be that a first step or the completion of an invention that cannot get a hearing now, but will be of untold benefit to the farmer, the housewife, the sailor or the merchant, hence to the nation, will make the year notable. The twelve-month may be marked by an investigation, an experiment that will lead to incalculable good in crop production. Mendel and his sweet peas were not in the national or scientific inventories of 1854, and his first contribution to the Society of Natu-

ralists of Brünn is referred to as "now memorable". Some law, mayhap, that stirred no oratorical rumblings, had no space in our newspapers, may give the present Philippine Congress a place in the country's annals while the laws now regarded highly will be preserved only in mildewed records. The Filipino vaudeville which has sprung into popularity in the past year would hardly find a place in our list, yet the future history of the Philippine stage may give the year because of these unfledged efforts a place not incomparable with certain years in the evolution of the English stage.

It is difficult to see happenings with even moderate accuracy when we are so near. Our vision is blurred, we magnify the wrong object. And we are stupid, indifferent to what is going on around us unless there is a blare of horns, a glare of color to herald popularity, then we too shout "It is great! It is wonderful!"

All history of man and of nature teaches us that beginnings of important things are small, obscure; that growth is quiet. But we do not learn. We go stumblingly on our way nudging aside and too often trampling on the important because it is unobtrusive.

In our College? Its events for 1923? The new roads, the new buildings, even the new flag staff, the athletic victories, the noted visitors, the meetings— these are the prominent events; are they the important ones? Even here where Science holds sway, where Truth is not crushed to earth, where the god of things as they are is worked for— are important events distinguished from prominent ones?

Some plant of future nation-wide benefit may have been added to the College cultures. Laboratory studies, that some day will be esteemed of such importance that the year 1923 will be a notable date in Philippine history of science may have been carried out on the Campus. But these are not of public record; they are unblazoned. Some student, some faculty member may have discovered some latent talent of unusual potentiality. We may have our Darwin, our Turczaninov, our Pasteur, our Burbank. Some Filipino Huxley may one day tell of the meeting in 1923, for the first time, of the Los Baños Biological Club.

If only we could list the important not the prominent events in 1924.

EMMA S. YULE
Of the Department of English.

SECOND ADDITION TO PHILIPPINE AND MALAYAN TECHNICAL BIBLIOGRAPHY

By Charles Fuller Baker

Dean, College of Agriculture

The first installment of this bibliography of published contributions, based wholly or in part on material furnished by C. F. Baker, was published in this journal in 1919 (**8**: 32-37)[1]. The second installment appeared in the same journal in 1922 (**10**: 363-366)[2]. The present installment shows increased activity and by many additional authors[3].

This enterprise—undertaken and carried privately—has now assumed a place of first importance among exploratory undertakings and faunal studies in Pacific countries. On January 1, 1924, there were one hundred and two of the most prominent specialists of the world in their various lines busily engaged on these materials—which have rapidly become more and more comprehensive in character. If work in the field should cease—which I hope will not occur—the studies in numbers of important lines will not be completed within ten years, so abundant have been some of the materials already supplied.

Special acknowledgements are due the specialists of Central Europe who have pushed the work ahead with great energy and activity in spite of the staggering economic conditions surrounding them and which in most cases has directly affected their lives in very serious fashion. Under a really terrible handicap they have yet carried out a great number of studies on this material, of the highest possible importance—the results in some cases being of monumental value. In addition to this, they have themselves procured publication in many cases when there was little or no public support for it and often at great personal sacrifice.

Out of this fundamental and absolutely necessary work in Malaya, is now coming much that will open up profitable lines of biological inquiry, and much that will lead to results of economic importance.

It is a matter of the profoundest regret that funds can not be found to keep the publishing up to date. The titles listed below represent only a part of the work actually finished at this time. Most notable works by Gebien, Heller, Obenberger, Krekich-Strassoldo and many others, still lie in manuscript awaiting publication. It has been hoped that enough interest among Americans could be aroused in this great undertaking in an insular possession and in one of the most interesting and important zoological regions of earth, to attract to it active support in the direction at least of publication. With the inspiring example of the Central European specialists before us it seems that we ought to find ways at least to give to the world the results of their splendid efforts under great difficulties—by comparison almost anything should be possible to people in really comfortable circumstances.

[1] One hundred sixty-five titles in seven years.

[2] Seventy-six titles in about four years.

[3] Sixty-two titles in the present list, or three hundred and three in all.

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In these later days the discovery of a new *Papilio* is quite an entomological event. The present species, *Papilio benguetana*, was discovered by C. F. Baker, at high altitude on Mount Santo Tomás at Baguio, Benguet Sub-Province, Northern Luzon. The authors do not extend to the discoverer the simple courtesy or justice of even mentioning his name.

STUDY OF RHIZOCTONIA BLIGHT OF BEANS[1]

By Cipriano C. Nacion

INTRODUCTION

In the Philippines, *Rhizoctonia* causes serious diseases of beans (*Phaseolus* spp.) and of many cultivated plants that have a mat forming habit. To a less extent the fungus is found on plants of a succulent nature, such as eggplant (*Solanum melongena* L.), maize (*Zea mays* L.), camote (*Ipomœa batatas* Poir), sugar cane (*Saccharum officinarum* L.) and rice (*Oryza sativa* L.), etc. Grasses growing on infected soil are often attacked. Also seedlings of succulent plants growing in damp habitats if they are crowded. The attack of the fungus is most serious during the rainy season, at which time the fields of beans are often entirely destroyed. *Rhizoctonia* is sometimes found associated with *Pythium*, a fungus which also attacks seedlings and young plants. In certain portions of the College fields during the latter part of the rainy season of 1921, the mungos, *Phaseolus mungo* Linn., used as a cover crop between the rows of *Averrhoa*, were so heavily infested with *Rhizoctonia* before the plants reached the flowering stage that they could not attain normal height. The fungus is undoubtedly the most common cause of the rotting of tobacco seedlings in the Philippines.

This *Rhizoctonia* has hitherto not been studied closely enough for the definite determination of its species.

THE DISEASE

GEOGRAPHICAL DISTRIBUTION AND ECONOMIC IMPORTANCE

The distribution of *Rhizoctonia* diseases is world wide. They seem to be more serious in regions where the climate is rather moist. Temperature apparently has little effect on the distribution of the disease.

On the American continents *Rhizoctonia* diseases are widely distributed in Brazil, United States, Canada, and some parts of Mexico. In Europe they seem to occur commonly from southern France eastward to Bavaria and Hungary and southward to the Mediterranean and from Germany and central France northward through Denmark, Norway, and Sweden. The fungus has been reported from Australia, Java, New Zealand, Japan, India, and some parts of Africa.

Reinking (1) reported *Rhizoctonia* blight of bean from the Philippines in 1918.

EXTENT OF DAMAGE IN THE COLLEGE FIELDS

Observation of the damage produced by the disease was made on young beans used as cover crop and on soy beans planted on the trial beds in the College fields. The writer observed that about 40 per cent of the young beans succumbed to the disease. On soy beans, planted in the trial beds, the loss caused by the attack of the fungus on the leaves and pods was about 30 per cent. The writer had occasion to observe the ravages of the disease on seed beds of tobacco

[1] Thesis presented for graduation from the College of Agriculture, No 163, Experiment Station contribution No. 209.

Prepared in the Department of Plant Pathology under the direction of Associate Professors C. G. Welles and Frank P. McWhorter.

and garden plants in the province of Pangasinan; there the loss due to damping off was estimated to be 40 per cent.

During damp weather the disease spreads with such remarkable rapidity that it is likely to become epidemic in character.

SYMPTOMS OF THE DISEASE

IN EARLY STAGES

There are several modes of infection of the disease. The fungus may gain entrance to the plant at the surface of the soil, attacking first the base of the stem and then the younger portions of the host. Sometimes in the case of procumbent hosts, the growing points and very young leaves become infected when they come in contact with the soil. Apparently ants and other animals, water, wind, and farm implements serve as carriers of the fungus. Anothe. and frequent means of infection is by diseased parts of plants falling over and touching healthy plants. When infection takes place in this way it generally starts at leaf tips, then spreads to the tender stems and even to the more matured stems. Injury of the stems or leaves is not necessary for infection; the fungus is able to penetrate through unbroken epidermal structures. In mature plants the infection is aerial.

In the case of soil infection, the most common source, the first appearance of the disease is the discoloring of the stems just above the surface of the soil and the permanent wilting of the leaves.

IN LATE STAGES

On the decaying stems and leaves of young plants a whitish mass of mycelium is apparent. On such young plants the fungus does not form any sclerotial bodies. On older hosts, where the tissues are old and contain lignified sclerenchymatous cells, the sclerotial bodies are formed within a short time after infection. Such hosts, in severe cases, are first covered with a dense whitish mass of mycelium. Later, white soft sclerotial bodies appear on the surface of the decaying leaves and stems. These bodies soon turn brown and hard and exhibit different forms, some rather spherical, some flattened with a diameter of one to three millimeters and a length of about six millimeters. They drop to the ground with the decaying leaves and stems and hibernate in the soil from season to season without losing their vitality. From these sclerotia under favorable conditions the mycelia are produced.

Shortly after the first appearance of the disease on the host the leaves and stems turn brown producing a soft watery mass in which numbers of protozoa (*Sarcodina* and *Infusoria*) may frequently be demonstrated. On the pods of beans ulcerations are produced at first; then the entire pods are covered with the mycelium of the fungus. When a host is severely infected it almost always dies.

The complete destruction of the host tissues is due partly to the saprophytic action of the *Rhizoctonia* fungus itself and partly to numerous bacteria that work with it.

CAUSAL ORGANISM

METHOD OF ISOLATION

The fungus was easily isolated by putting sclerotia obtained from the decaying stems and leaves of the patani (*Phaseolus lunatus* L.) on corn meal in petri dishes incubated for twenty-four hours. From this young mycelial growth of the fungus transfers were made into potato agar slants.

CULTURAL CHARACTERS OF THE FUNGUS

The growth of the fungus on different media was studied in the laboratory. Observations were made daily for one month and then weekly for about two months. For purposes of comparison it was found necessary to start all the cultures with approximately equal sized sclerotia or bits of mycelium.

Potato agar.—On May 13, 1922, sclerotia of approximately equal sizes were transferred to potato agar slants. In three days, clusters of soft, white, rounded sclerotia were seen developing; these turned hard and black after seven days. Numerous sclerotia were formed. After twenty days both mycelium and medium turned black.

Growth on oat agar.—On May 13, 1922, transfers were made to oat agar slants. After two days white soft sclerotia began to develop; they turned hard and black after seven days. New sclerotia continued to form for twenty days. These sclerotia were larger in size than any of those formed in the other media used; they were of the same size as those found on the host, patani. After one month the fungus filled two thirds of the test tube with a brown feathery mass of mycelium.

Growth on rice agar.—On June 14, 1922, equal sized sclerotia were transferred from patani to rice agar slants. After four days young, white soft sclerotia were developed in clusters which later on became hard black masses. The mycelium turned brownish after twenty days.

Growth on potato-glucose agar.—Bits of mycelium of approximately equal size were transferred to potato-glucose-agar slants. In three days white soft sclerotia were produced. After twenty days numerous hard, black, and somewhat rounded sclerotia were seen. After a month the mycelium and medium turned reddish brown.

Growth on sterilized old stems and pods of Phaseolus lunatus.—The growth of the fungus on the stems and pods was rapid exhibiting the same characteristics as on oat agar slants. The sclerotia were large and rounded but dark brown in color like those found on infected hosts in the field. After one month the fungus filled two thirds of the test tube with a brown feathery mass of mycelium. Numerous sclerotia were formed.

Growth on sterilized young pods and stems of Phaseolus lunatus.—On each of these media the fungus showed a poor growth. After four days, scanty, white, radially growing mycelia were noted. The mycelia were never dense although the individual strands were long, covering almost the entire surfaces of the media. Very few sclerotia were developed. After twenty days the mycelia turned brown and the media decayed.

Growth on plain agar.—Although several transfers were made no growth was obtained on plain 1.5 per cent water agar.

MORPHOLOGY OF THE FUNGUS

A morphological study of the characteristics of the hyphæ and sclerotia was made.

The hyphæ of the fungus are extracellular and intracellular. The external development of the hyphæ is more or less web-like. The color is usually yellowish brown but when young they are practically colorless. Under a four millimeter lens the young hyphæ may be seen to be somewhat vacuolate. They are septate and the distances between the septæ are irregular. Measurements

show that the cells of the hyphæ are 102-200.6 microns × 7.8-9.2 microns. It was found that cells of the young hyphæ are short and become longer as they grow old. Branches arise on these hyphæ at any free end. When young they are inclined in the direction of growth of the main hyphæ and are constricted at the point of union with the main hyphæ. As they advance in age the hyphæ become darker, more uniform and rigid. The branches in the old mycelia are almost at right angles to the main axis.

The hyphæ which are intracellular are colorless and this color remains as long as there is active growth. They are vacuolate. They exhibit the same general characteristics as those of the extracellular hyphæ.

The sclerotia vary in size. The largest noted was 4 millimeters in diameter. They are generally flattened and irregular. When young they are smooth, white and soft, and when old they are smooth, black and hard The cells in the sclerotia form a homogeneous structure.

In young cultures the hyphæ are colorless, vacuolate with rather irregular septæ. They show the same characteristics as those on the host.

The sclerotia in cultures are similar in appearance and structure to those on hosts in the field.

TAXONOMY

From the microscopical examination of the mycelium and the sclerotia of the organism, it was found that the characters of the hyphæ and sclerotia, conform closely to those of Duggar (2) for *Rhizoctonia solani* Kühn.

The measurements of hyphal cells of the fungus given above are very close to those of Duggar which are 100-200 microns × 8-12 microns.

Morphological and cultural characters indicate that the Phillippine *Rhizoctonia* is *R. solani* Kühn.

PATHOGENICITY

With pure cultures of the organism taken from its patani host, inoculation experiments were made to determine possible hosts and the effect of the organism on them under controlled conditions. In this work, a series of experiments were carried on in the laboratory of the Department of Plant Pathology. All possible precautions were taken to prevent contamination.

There were three methods of inoculation used: (1) Inoculation through slits in stem; (2) inoculation through punctures on leaves; (3) inoculation from the soil.

INOCULATION THROUGH SLITS IN STEM

Three seedlings each of patani (*Phaseolus lunatus* Linn.), mungo (*P. mungo* Linn.), cowpea (*Vigna sinensis* Linn.), and soy bean (*Glycine max* (Linn.) Merr.) were inoculated in August 9, 1922, with a pure culture of the fungus. The stems were sterilized with mercuric chloride (1:1000) and after 10 minutes washed with three changes of sterile water. Small slits were made in the stem with a sterile sharp-pointed scalpel, and bits of mycelium of the organism used were inserted into the slits by means of a sterile platinum needle. Control plants were maintained for each case. The experiment was conducted in a damp chamber.

The plants inoculated were all infected within two days. This was shown by blackening on one side or around the stem at the place where slits were made. These black portions were moist, and sticky fluids oozed from the slits. After one week the plants fell over; death followed four days later. The plants were

reduced to a soft mass covered with whitish mycelium. Later, sclerotial bodies were produced which showed definitely that the destroying organism was a *Rhizoctonia*. The causal organism was re-isolated and was found to be identical with the one in the culture.

INOCULATION THROUGH PUNCTURES ON LEAVES

On August 18, 1922, the same varieties of beans were inoculated using three healthy seedlings of each.

Bits of mycelium were placed on punctured and unpunctured leaves. Control plants were also maintained. The experiment was carried on in a damp chamber. Within two days the plants showed symptoms of blight. The infected leaves were at first somewhat yellowed in blotches. Then they gradually turned black, became moist, and fell to the ground in a soft mass. Both punctured and unpunctured leaves were infected. Within one week the plants fell over in a soft mass and decayed. White masses of mycelia formed a covering on the decaying plants and later on sclerotial bodies were produced which confirmed the infection. The control plants were not infected. The fungus was re-isolated.

INOCULATION FROM THE SOIL

On August 14, 1922, three sound seedlings each of patani and cowpea were planted in sterilized soil and inoculated with the fungus after the seeds were planted. On August 19, 1922, three sound seedlings each of mungo and soy bean were inoculated in the same manner. These seedlings and suitable controls were kept in a moist chamber.

After five days there were characteristic ulcerations on the stems of the seedlings just above the surface of the ground. These ulcerations, which were moist and black, either extended around the stem or were confined to one side. Within two days from the first appearance of the disease, the plants, although the leaves were not wilted, fell over. The attack of the fungus continued until the entire plants were reduced to soft shapeless heaps covered with white masses of mycelium which eventually produced sclerotial bodies. In some instances it was observed that seedlings developing on infected soil were destroyed before they reached the surface of the soil. Such cases were due to the attack on the plumules. The control plants remained healthy. The organism was re-isolated and it was found to be identical with the original organism.

Further inoculation experiments carried on in a damp chamber showed that the fungus isolated from patani was able to kill seedlings of *Nicotiana tabacum* Linn., *Arachis hypogœa* Linn., *Ipomœa batatas* Poir., *Zea mays* Linn., and *Capsicum* spp.

COMPARATIVE PATHOGENICITY OF THE PHILIPPINE RHIZOCTONIA AND R. SOLANI

On October 14, 1922, three sound seedlings of potato were inoculated with the fungus, and at the same time three other sound seedlings of potato were inoculated with a culture of *R. solani* Kühn, obtained from the United States Department of Agriculture, Washington, D. C.

After taking precautions to prevent contaminations sclerotial bodies were placed upon the leaves and tender portions of the stems. The plants inoculated with the Philippine strain were placed side by side in a damp chamber with the plants inoculated with *R. solani* Kühn. Control plants were maintained in both

cases. By October 15, the seedlings were infected. Yellow blotches appeared on the leaves and the stems began to rot and turn black gradually. Six days after the first appearance of the disease the seedlings fell over and decayed. White masses of mycelia were seen on the decaying plants in both cases. The mycelia turned brown as they became older. Both organisms similarly attacked the hosts and killed them almost at the same time. The control showed no signs of infection.

In the comparative inoculation experiments the Philippine and American strains produced identical symptoms of the disease.

DISCUSSION OF RESULTS

The inoculation experiments showed that the Philippine *Rhizoctonia* readily infects succulent plants. The diseased portions produced on all the hosts were identical in nature. The chief characteristics were moist black spots and subsequent rotting.

The results of inoculating the plants through punctured leaves showed that the organism was able to cause infection and blight on the leaves of the host within one day. The fungus killed the hosts in about the same time. Only one general type of disease was produced on all the hosts.

The results of inoculations through the soil showed the production of the characteristic ulcerations on the stems just above the surface of the soil. The length of time required to produce the ulceration was less than five days and within a short time thereafter the fungus killed the hosts. There were no apparent variations in the incubation periods of the disease on each of the hosts. The seriousness of the disease was the same in all cases.

Other inoculation experiments showed that the fungus under favorable conditions may infect not only beans but also many succulent and some woody plants. In the case of succulent plants, crowding and damp soil favor the disease. Ants or other animals, water, wind, etc., are means of disseminating the fungus.

Wet soil, damp air, and crowding of seedlings were found to be favorable for the proper and rapid development of the disease. Sunlight will retard the growth of the fungus. During rainy days the disease developed rapidly and natural field infections were prevalent.

It was also found that the Philippine strain of the fungus attacks potato in the same manner as a known culture of *R. solani* Kühn. It appears that the Philippine fungus is *R. solani* Kühn.

CONTROL MEASURES

From the results given above and observations, several control measures may be recommended.

1. Avoid thick planting and the matting of plants on the ground.
2. Planting should be done so as to escape the rainy season since the disease is severe during the wet months.
3. Crop rotation should be practiced inasmuch as sclerotial bodies fall to the ground and remain alive for a long period. In the crop rotation plants should be grown that do not form a mat over the ground.
4. Avoid planting or germinating seeds on unsterilized soils.
5. Sanitation should be practiced.

SUMMARY

1. There is apparently only one species of *Rhizoctonia* found on *Phaseolus lunatus* in the Laguna region.

2. This fungus kills its hosts within a short time. It attacks all succulent plants that have a mat-forming habit.

3. The fungus is very virulent during the rainy season and will attack any crop that forms a mat over the ground.

4. The types of disease induced are damping off and root or stem rots.

5. The mycelium and the sclerotia, as well as the general appearance on the host and the way it attacks its host, show that the Philippine species of *Rhizoctonia* is *R. solani* Kühn.

6. The fungus is readily culturable by the usual laboratory methods.

7. This fungus is found among the beans and other plants in the College fields.

8. No perfect stage of the fungus was observed.

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SOME METHODS FOR PRESERVING MANGOES[1]

By CALIXTO T. ZAMUCO and PATRICIO LOMIBAO

By residents of this country the mango has long been recognized as the most delicious of the Philippine fruits. But its superior qualities are little known outside the tropics as it is not exported fresh in any quantity, and little has been done in finding out methods for preserving the fruit.[2] As the mango quickly decays, the poor refrigerating facilities at present do not warrant making any attempt to export this fruit, fresh.

The object of the experiments reported in this paper was to find out a good method of preserving mango and thus make it available for export.

MATERIALS AND EQUIPMENT

The "carabao" variety of mango, the best grown in the Philippines, was used in this work. The fruit was obtained from Pangasinan Province. The average size of this mango is about 15 centimeters in length and 8 centimeters in diameter. It weighs approximately 260 grams when ripe. Well-matured mangoes, with either the cavity or the stigmatic point turning yellow, were picked without bruising and allowed to ripen with the least possible disturbance of the bloom.

In the sulphuring and drying processes, drying trays consisting of a wooden frame and bamboo floor were used. Each tray was 52 centimeters long, 37 centimeters wide and 5 centimeters deep (inside measurements). The principle of construction was similar to that followed by Root (1). The trays were provided with cheese cloth covers. The drying fruit was kept as free from dust and insects as possible. Besides contaminating the fruit, the insects may deposit eggs the larvae of which when they hatch ruin the preserved product. Enough ventilation was provided for constant removal of the moisture given off by the contents of each tray (2).

A sulphuring box 53 centimeters long, 38 centimeters wide, and 1 meter high was made from a packing box. It was so constructed that a space 20 centimeters high was left for a sulphuring stove. The trays were fitted into the box and rested upon cleats fastened to the sides of the box, the distance between the cleats being one centimeter more than the depth of each tray. Several holes were made in the top of the box for the escape of the sulphur fumes.

A copra drier was utilized for dehydrating the fruit at an average temperature of 67° C.

A hand sealer was used for sealing the cans.

The materials used in preserving the fruit were flowers of sulphur for sulphuring and refined sugar for making syrup. For dividing or slicing the mangoes, a

[1] Part of thesis presented for graduation from the College of Agriculture, No 164; Experiment Station contribution, No. 210. Prepared in the Department of Chemistry. Experiments under direction of Assistant Professor Kenward. Extracts from thesis made and arranged by Dr. F. O. Santos.

[2] Samples of dried mangoes sent by the Tropical Food Products Corporation, Bauang, La Union, to different places in the United States and exhibited twice (1922 and 1923) at the Philippine Carnival, Manila, received favorable comment as to their superior qualities. Considerable quantities of canned mangoes are being put on the Manila market by the Philippine Fruit and Packing Company of Orion, Bataan, with a fair degree of success

silver plated knife was used as a steel knife discolors the fruit. The equipment also included a thermometer, shellaced tin cans, preserving kettles, waxed paper bags, and waxed boxes.

METHODS OF PRESERVING

PREPARATION OF FRUIT

The mangoes were carefully picked and kept in an inclined position and as close as possible to each other in a clean warm room. In placing the fruit the stigmatic point was upward and the cavity downward so as to allow the sticky juice to ooze out without coming in contact with the fruit.

When the mangoes were yellow and fairly hard, they were considered properly ripened for canning and dehydrating.

Before weighing and labelling, the fruit was cleaned then classified as to size, degree of ripeness, and freedom from disease. The selected mangoes peeled or unpeeled were cut into halves or quarters and the seeds taken out. They were then dipped at once in a two per cent salt solution for the purpose of preserving the color as well as improving the flavor of the fruit.

Immediately on taking the fruit from the salt solution, it was placed on trays for sulphuring or drying or into the preserving syrup for canning.[3]

SUN DRYING

Without sulphuring.—The first set consisted of peeled and unpeeled mangoes divided into halves and quarters, dried in the sun in separate trays covered with cheese cloth and placed on an elevated bamboo floor. Solar driers may be used instead of trays to effect more rapid evaporation (2).

The second set was similar to the first except that the trays were placed on the sod.

The third set was dried on a cement floor.

In all cases of sun drying, shelters were provided at night to protect the drying fruit from rain or dew.

Sulphuring followed by sun drying.—Caldwell (2) claims that as soon as the flesh of the fruit is exposed to the air, chemical changes in the tissues begin. Some of these changes produce darkening and discoloration of the tissues; others break down the pigments present causing the fading of the characteristic colors and the natural flavor is lost at the same. Many lower organisms always present in the air and upon foodstuffs, such as bacteria and molds which produce rapid decomposition, are certain to begin growth either on the surface of, or inside, the material. These chemical changes and actions of organisms can be checked by raising the temperature of materials from 175° to 185°F. But it is not possible to do this without causing injury to the flesh of the fruit. The rapid heating at this temperature in dry air of freshly cut succulent fruit or vegetables causes the bursting of the cell membranes by expansion of their contents and permits the dripping of water which carries with it dissolved sugar, salts, and flavoring substances thus affecting both the palatability and the food value of the product. Consequently only moderate temperature can be employed. Unfortunately, practically all the changes under discussion are not only allowed to continue but are also hastened when the temperature of the fresh water-filled material is raised

[3] Drying is a technical term for sun drying; evaporating, for drying fruits by artificial heat (3).

to the limit beyond which bursting and dripping will occur. To arrest these changes and to preserve the natural color and flavor of the fruit, it is necessary to resort either to blanching or sulphuring. For these reasons, the following sets of experiments were undertaken.

The fourth set was divided into four classes: (a) the mango halves unpeeled; (b) the mango quarters unpeeled; (c) the mango halves peeled; and (d) the mango quarters peeled. All of these classes were sulphured for twenty-four hours and then sun dried on a bamboo floor.

The fifth set consisted of peeled mangoes quartered, sulphured for two hours before sun drying.

The sixth, seventh, and eighth sets were also peeled and quartered and sulphured for one and one-half hours, one hour, and one-half hour, respectively before sun drying.

DRYING BY ARTIFICIAL HEAT

The following sets of experiments were conducted to determine: (a) whether a better quality of fruit could be obtained; (b) whether the period of dehydration would be less than that of sun drying by using artificial heat and working independently of weather conditions; (c) whether the mango could be dehydrated successfully without sulphuring.

The tenth set of peeled and quartered mangoes was dehydrated without sulphuring.

The eleventh set was sulphured for one hour and then evaporated.

The twelfth set was sulphured for one-half hour and then evaporated.

In drying and evaporating, the fruit was turned occasionally to prevent its scorching and sticking to the bottom of the trays and to insure uniform drying. Experience alone enables one to determine the right intervals between turnings (3). In this work the drying mangoes were turned every two hours in the beginning of the operation and more frequently towards the end.

To be able to recognize when the fruit is properly dried is also a matter of experience. A good practical test is to take a handful of slices, press them together firmly into a ball, if "springy" enough to separate at once upon being released from the hand the fruit is sufficiently dry. Another test is when no free juice is visible when freshly cut sections of the dried materials are pressed hard (3)

TREATMENT AFTER DRYING

All mangoes sun dried or dried by artificial heat were allowed to sweat in a warm dark room.[4] They were placed in the trays properly screened with cheese cloth. Every day or two the dried materials were stirred thoroughly until the moisture content of the entire mass became uniform and the fruit neither absorbed nor gave off measurable quantities of moisture. The aim here was to equalize the moisture content of every piece of dried mango, because no matter how much care was exercised in drying, some portions contained too much moisture for storage, while others seemed too dry.

After curing, each set of mangoes was placed separately in waxed paper bags properly labelled and sealed with paraffin. The bags were then packed in tins, lined with layers of paraffin paper, each layer being so placed that the join-

[4] Caldwell claims that light destroys the color of the fruit (2).

ings of the preceding layer were broken. The upper edges of the paper were left long enough to be folded over the top when the tin was filled with mangoes. The tins were wrapped with waxed paper and sealed with paraffin.

CANNING

It is claimed that the original form, flavor, color and texture of fruit are retained to a greater degree by canning than by any other means of preservation (4). To determine which was the best, three different syrups were used in canning the mangoes: (a) thin; (b) medium; and (c) thick syrup.

Thin syrup.—The thin syrup consisted of one part water to one part sugar by volume. This mixture was heated to the boiling point. The fruit was then dropped into the syrup and boiled for five minutes. This open kettle cooking reduced the volume and seemed to toughen the tender fibers of the fruit. Shellac lined cans were filled and sealed with a hand sealer, then stored.

Medium syrup.—The medium syrup consisted of three parts sugar to two parts water by volume, heated until the boiling point was reached. This mixture was boiled for five minutes before dropping in the halved mangoes. The cooking, canning, and storing were the same as with the thin syrup.

Thick syrup.—The thick syrup was prepared by mixing two parts of sugar with one part water by volume, heated gradually until the boiling point was reached. This mixture was allowed to boil for ten minutes before the halved mangoes were dropped into it. Then the fruit was cooked for ten minutes in this syrup.

RESULTS

Before packing and for six months thereafter, the dried fruit was closely observed for appearance, attractiveness, etc.; and tasted for flavor and palatability. The color, flavor and other qualities of the fruit were noted when each can was opened. These observations together with the essential points in manipulation follow.

SUN DRIED

Set No. 1a.—Unpeeled mango halves dried with trays on bamboo floor. This group was dried for 58 hours at an average weather condition[5] of 5/12 sunny, 2/12 cloudy, and 5/12 rainy. The percentage of material lost amounted to 74[6]. The dried product was black in color due to molds and was unfit for food.

Set No. 1b.—Unpeeled mango quarters dried with trays on bamboo floor. This group was dried for 56 hours at an average weather condition of 5/12 sunny, 2/12 cloudy, and 5/12 rainy. The percentage of material lost amounted to 81. The dried product was the same as Set No. 1a.

Set No. 1c.—Peeled mango halves dried with trays on bamboo floor. This group was dried for 49 hours at an average weather condition of 3/4 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 85. The dried product was light to dark brown in color, attacked by molds, and unfit for food.

Set No. 1d.—Peeled mango quarters dried on bamboo floor. This group was dried for 48 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 90. The dried product was brown in color, attacked by molds, and quite unfit for food.

[5] Wind condition was not included because it was practically the same throughout the drying experiments.
[6] Materials lost, include the rind, fibrous seeds, and the moisture evaporated.

Set. No. 2.a—Unpeeled mango halves dried with trays on sod. This group was dried for 65 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 89. The dried product was black in color, badly infested by molds, and unfit for food.

Set No. 2b.—Unpeeled mango quarters dried with trays on sod. This group was dried for 63 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 87. The dried product was black in color, attacked by molds, and unfit for food.

Set No. 2c.—Peeled mango halves dried with trays on sod. This group was dried for 64 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 90. The dried product was black in color, attacked by molds, and unfit for food.

Set No. 2d.—Peeled mango quarters dried with trays on sod. This group was dried for 62 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 91. The dried product was dark brown in color, attacked by molds, and unfit for food.

Set No. 3a.—Unpeeled mango halves dried with trays on cement floor. This group was dried for 44 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 83. The dried fruit was dark brown in color, attacked by molds, and unfit for food.

Set No. 3b.—Unpeeled mango quarters dried with trays on cement floor. This group was dried for 42 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 90. The dried product was similar in color to Set No. 3a.

Set No. 3c.—Peeled mango halves dried with trays on cement floor. This group was dried for 42 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 92. The dried product was light brown in color, considerably infested by molds, edible but quite sour.

Set. No. 3d.—Peeled mango quarters dried with trays on cement floor. This group was dried for 41 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 92. The dried product was similar in color to Set No. 3a.

SULPHURED[7] AND THEN SUN DRIED

Set No. 4a.—Unpeeled mango halves, sulphured for 24 hours and dried with trays on bamboo floor. This group was dried for 44 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 74. The dried product was bright yellow in color, fresh, adhered well to the rind which rolled up, but was of questionable food value due to sulphur dioxide.

Set No. 4b.—Unpeeled mango quarters, sulphured for 24 hours and dried as Group No. 4a. This group was dried for 43 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage materials lost amounted to 79. The dried mangoes were similar to Set No. 4a.

Set No. 4c.—Peeled mango halves, sulphured for 24 hours, and dried as Set No. 4b. This group was dried for 41 hours at an average weather condition of

[7] For every 5.65 grams of fresh mango, 1 gram of sulphur was used.

3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 85. The dried mangoes were similar to Set No. 4b with the exception that there was no rind.

Set No. 4d.—Peeled mango quarters, sulphured for 24 hours and dried as Set 4b. This group was dried for 40 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 86. The dried mangoes were similar to Set No. 4c except that they were more attractive in color.

Set No. 5.—Peeled mango quarters, sulphured for two hours and sun dried with trays on bamboo floor. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 85. The dried mangoes were attractive yellow in color, subacid in taste, smelled of SO_2 and were of questionable food value.

Set No. 6.—Peeled mango quarters, sulphured for one and one-half hours and dried as Set No. 2. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 87. The dried mangoes were similar to Set No. 5.

Set No. 7.—Peeled mango quarters, sulphured for one hour and dried as Set No. 6. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 86. The dried mangoes were attractive deep yellow in color, sweet, and quite good for food.

Set No. 8.—Peeled mango quarters, sulphured for 1/2 hour and dried as Set No. 7. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 87. The dried mangoes were attractive, yellowish in color, sweet, nutty, and good for food.

Set No. 9.—Treated as Set No. 8, but dried on cement floor. This group was dried for 33 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 87. The dried mangoes were similar to Set No. 8.

DRIED BY ARTIFICIAL HEAT

Set No. 10a.—Peeled mango halves, unsulphured. This group was evaporated for a period of 21 hours. The percentage of material eliminated amounted to 87.8. The evaporated mango was light-bright to yellowish in color, subacid and nutty in flavor, slightly attacked by molds, and quite good for food.

Set No. 10b.—Peeled mango quarters, unsulphured. This group was evaporated for a period of 14 hours. The percentage of material eliminated amounted to 87.8. The evaporated mango was the same as in Set No. 10a.

Set No. 11.—Peeled mango halves, sulphured for one hour. This group was evaporated for a period of 17 hours. The percentage of material eliminated amounted to 87.6. The evaporated mango was bright yellow to light red in color, subacid, nutty in taste, had traces of SO_2 and was quite good for food.

Set No. 12a.—Peeled mango halves, sulphured for one-half hour. This group was evaporated for a period of 22 hours. The percentage of material elimminated amounted to 87.5. The evaporated mango was attractive yellow to light red in color, sweet to subacid, nutty flavor, and good for food.

Set No. 12b.—Peeled mango quarters, sulphured for one-half hour. This group was evaporated for a period of 11 hours. The percentage of material eliminated amounted to 87.5. The evaporated mango was the same as in Set No. 12a.

CANNED MANGOES

The mangoes in thin syrup were canned May 1; medium syrup, May 2; and thick syrup, May 3, 1922. On July 21, 1923, all the fruit still retained its natural yellowish color, had a flavor varying from subacid to sweet, semi-melting consistency, and retained the semi-firm texture of the flesh. All the three kinds were good to eat; but those in medium syrup were a little too sweet, and those in thick syrup, very sweet, thus affecting the flavor. Even up to November 19, 1922, the mangoes were still in as good condition as in July of the same year.

DISCUSSIONS OF RESULTS

In the unpeeled fruit, the loss due to elimination of seeds and water ranged from 74 to 90 per cent. By taking off the rind, the loss was from 85 per cent to 92 per cent. The reduction in the bulk of the fruit evaporated by artificial heat averaged 88 per cent.

It took less time to dry the peeled mangoes than the unpeeled ones. This was because the rate of evaporation of moisture from the exposed flesh of the fruit was greater than from the part covered by the leather-like rind. A shorter time was required to dry the quartered mango than the halved in all sets of experiments because more surface area of the quartered mangoes were exposed to the air than in the halved.

The evaporation of mango moisture was most rapid with trays on the cement floor, although the weather conditions were more unfavorable (being 1/3 sunny, 1/3 cloudy, and 1/3 rainy) than during the drying on bamboo floors or sod. This is in harmony with Caldwell's explanation that the evaporation of water from grass composing the sod forms a vapor blanket which retards the drying. With the bamboo floor, there was free movement of air currents beneath as well as over the trays which materially aided the drying. Although on the cement floor there was not much circulation of air beneath the trays, there was much more heat absorbed by the cement floor and reflected to the trays, thus contributing heat in addition to the direct rays of the sun. In the absence of a cement floor, a platform elevated a few meters above the level of the ground could be utilized.

It is believed that sulphured fruit dries more quickly than unsulphured (3). In this experiment the unsulphured mangoes dried within 49 hours under Set No. 1c and within 48 hours under Set No. 1d. The sulphured fruits in trays on the same bamboo floor under unfavorable weather conditions dried within 41 hours under Set No. 4c and within 40 hours under Set No. 4d (giving a difference of about 8 hours in each case.) Peeled mango quarters sulphured for one-half hour dried within 33 hours in trays on bamboo floor and with weather conditions more cloudy and rainy than those under which the unsulphured mangoes were dried.

The average length of time required in evaporating by artificial heat was found to be much less than sun drying, the shortest time for sun drying being 33 hours while the maximum time in evaporating was 22 hours, at a temperature of 67°C. The reason for this difference is obvious, as artificial drying is independent of weather conditions; and in this the temperature at which evaporating was done was higher than the temperature in sun drying.

The black color of the unpeeled, unsulphured mangoes was largely due to the presence of mold on the surface of the fruit and to discoloration resulting from the chemical changes within the fruit. The growth of molds was accelerated by the unfavorable weather conditions, two thirds of the time being cloudy or rainy. The molds had ample time to develop before the mangoes became dry enough to prevent their growth. To the same causes are attributed the unattractiveness and unfitness for food of the peeled, unsulphured, and sun dried mangoes.

On the other hand both the unpeeled and peeled mangoes sulphured for 24 hours and sun dried were free from mold and had an attractive yellowish color, but they retained enough sulphur dioxide to make them questionable food material. The rind of the fruit could hardly be removed from the flesh.

The peeled mangoes, sulphured for two hours, one and one-half hours and one hour respectively and then sun dried were free from mold and had an attracttive appearance; were subacid and nutty in flavor. Those sulphured for one-half hour were free from mold also and attractive, palatable, and seemingly a wholesome food.

The fruit evaporated by artificial heat and unsulphured had a dark unattractive color, was subacid and nutty in flavor and quite good for food. The molds did not gain a foothold on the fruit while drying.

The peeled mangoes sulphured for one-half hour and evaporated at an average temperature of 67°C. were free from mold and were the best dried product obtained. The fruit was attractive, yellowish to light red in color, nutty sweet and palatable, hence good for food.

Of the canned mangoes those preserved with the thin syrup retained their natural yellowish color, were subacid in flavor, semi-melting consistency and semifirm texture. Hence, they were good for food.

Practically the same good qualities of the fruit were observed in the medium and thick syrup, except that the natural flavor of the mangoes was affected by the increased sweetness of the syrup.

SUMMARY

(1) The great advantage of drying or evaporating mangoes over any other means of preservation is the immense reduction in bulk of the fresh fruit.

(2) Mangoes at the stage of proper ripeness when peeled, quartered, and sulphured for one-half hour, dried more quickly than when not sulphured and gave up their moisture more rapidly in trays on a cement floor than on either bamboo floor or sod.

(3) The same kind of mangoes as described in (2) but evaporated independently of weather conditions by using artificial heat at an average temperature of 67°C. proved to be better in appearance and flavor than was obtained by sun drying.

(4) Canned mangoes with thin syrup retained their attractive natural color, subacid to sweet flavor and semi-melting consistency to a greater degree than by any other method of preservation tried.

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SEEDINESS IN PINEAPPLES[1]

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The occurrence of seeds in pineapples has given rise recently to considerable inquiry and concern on the part of some who are interested in the pineapple industry. The Cayenne variety which is the foundation of the world-renowned Hawaiian industry, and is grown extensively in Queensland and other parts of the tropics and sub-tropics has been considered a practically seedless variety. Only a little more than a decade ago seeds in the Hawaiian pineapple plantations were considered curiosities by the layman and were eagerly sought by the plant breeder as a possible source of new and valuable varieties. Today they are occurring with a frequency which has caused some uneasiness, for seeds in a pineapple are distinctly objectionable because of the inconvenience and undesirable appearance to which they give rise.

The Cayenne pineapple was introduced into the Philippines from Hawaii and one or more plantations of commercial importance are now in operation. A statement has become more or less widely circulated that seediness is more common here than elsewhere. Those who are interested in the development of the pineapple industry and are cognizant of the vast areas in the Philippines that are adapted to the crop are concerned to know whether this is in accordance with the facts. I have been asked for an opinion on this subject. After four years of residence in the Philippines during which time I have visited the most important plantings and have grown the variety at the College of Agriculture, I have found no evidence that seeds in the Cayenne occur more frequently here than in Hawaii when grown under similar conditions. These findings have been confirmed by men most closely in touch with pineapple growing here including those who have no financial interests in the industry.[2]

The cause of this false impression, which apparently is not of local origin, probably lies in the fact that most of the pineapples which have been canned in the Philippines do contain many seeds. But these fruits are not of the Cayenne variety but rather of a wild or semi-wild form grown in waste places. Until quite recently there have not been enough Cayenne to supply the local market with fresh pineapples and the prices have been so high for these large, juicy, attractive fruits that practically none of the crop was diverted to the cans. The semi-wild pineapple is grown by the Filipino farmer in the shade of other plants where it receives little or no care or cultivation other than the occasional cutting away of the grass and underbrush. But considerable quantities of fruit in the aggregate come from these sources and such has been bought and canned. All this is now being changed as the quantity of Cayenne fruit is increasing and the latter will soon entirely replace the inferior and seedy variety.

[1] Experiment Station contribution No 211

[2] The subject has been discussed with Mr. B. A. Green and Mr. George C Sellner both of whom have had long experience in the pineapple business in the Philippines and with Mr Teodorico P. Reyes and Mr. Leon G. Gonzales of the Agronomy Department of the College of Agriculture and with others

There are several other varieties of pineapple grown in the Philippines, including the Queen and a number of strains of the Spanish (Red Spanish). Some of these forms produce seeds abundantly and the Spanish is frequently seen in the Manila market with the so-called native variety and occasionally a few others. In recent years there have been many Cayenne.

CAUSES OF SEEDINESS IN PINEAPPLES

In seeking an answer to the inquiry as to the cause of seediness in the Cayenne, the question should first be what is the cause of seedlessness for the production of seed is normal. Some varieties of fruit plants are incapable of producing seeds without the assistance of pollen from some other variety. Some are incapable of even producing a fruit crop. This principle is so well known among orchardists that the mutual relations of many varieties have been worked out and certain varieties are known to be effective pollinizers of other varieties. The Cayenne variety of pineapple can produce fruit without the influence of foreign pollen, but under these conditions it seldom matures seed. It has been demonstrated that seeds can be developed in the Cayenne if pollen from certain other varieties is applied by hand. The same is true of other seedless varieties.

However, while it is true that the Cayenne is usually seedless it does not follow that every individual without exception possesses this character. Plants mutate and suddenly new characters appear. It is not at all impossible that an individual may appear possessing self-fecundating flowers even among these asexually propagated plants. These would merely represent bud-mutations and are probably in the direction of earlier forms. Such mutations, or bud "sports" are well known throughout the field of horticulture and have given rise to many valuable new varieties when the mutation has been in the direction of improvement. Undesirable mutations are quite as common as those that present some new desired character. Whatever these characters may be that arise in a bud-mutation, they are likely to be constant when the new individual is propagated by vegetative parts as is the practice with pineapples.

With these facts in mind, let us consider the history of seed occurrence in Hawaiian pineapple growing. For the first years of the industry seeds in the Cayenne variety were almost unknown. Later an occasional fruit was found in which seeds were very abundant and the fruit was discarded by the canners. But the growers as well as the professional horticulturists welcomed them as possible sources of new and valuable seedling varieties that might be resistant to some of the troublesome diseases. The seeds were gathered at first only a few at a time, and later by the hundreds and thousands and were planted under very carefully arranged conditions to insure germination. Later, these seedlings were transferred to the pineapple fields and the growing of such chance seedlings as well as those that have resulted from hybridization carried on intentionally by the breeders has become a very important phase of pineapple investigations in Hawaii. Most of these plants have been set either in the fields of the commercial plantations or adjoining them. Concerning these it is to be remembered that each seedling is essentially a new variety whether of hybrid origin, or otherwise, since the pineapple cannot be depended upon to reproduce its characters accurately through seed propagation. It is also to be remembered that many of the thousands of new varieties are themselves seedy.

The present increased frequency of seed occurrence may be attributable to one of several causes or to a combination of them. Mutation alone might account for a large part of the cases of seediness. Even if only one case of such bud-mutation occurred its effects would go on multiplying indefinitely for from this plant in the first year a crown and several suckers and slips might be planted and in the following years several more from the original plant and a further supply from each of the first generation of the asexually propagated progeny. There are no external characters discovered that are known to be correlated with seediness and hence the plant is not recognized in the field as different from any other and propagating material is taken from it even including the crown before the seedy character of the fruit is discovered, and it is then too late to identify the plant that gave rise to the seedy fruit. Thus, given only a single mutation, there would be in a period of ten or fifteen years a marked increased frequency of seed occurrence even though a considerable portion of the propagating material were not used. It is not improbable, however, that several such bud-mutations may have occurred.

Another known cause of seed production is cross-pollination. As stated above it has been demonstrated that the Cayenne pineapple can be made to produce seed by hand pollinating its flowers with pollen from other varieties. To what degree cross-pollination may take place by natural means when different varieties are planted in close proximity cannot be stated. It is reasonable to assume, however, that increasing the number of varieties in the vicinity of a normally seedless plant would increase the probabilities of the transfer of effective pollen to the stigmas of such plant. Likewise, the increasing of the number of individuals of any fecundating variety would in the same way increase the probabilities of seed formation.

In the early days of the pineapple industry in Hawaii only one recognized variety was grown extensively, although there were several other practically seedless varieties grown for trial on a very small scale. Then it came to be recognized that there were different forms which were regarded as possibly only different strains of the Cayenne. Some of these are known to represent different introductions and are perhaps sufficiently distinct to be classed as different varieties. Each is normally seedless but so far as the writer is informed the effect of the pollen of any of these upon another has not been determined. More than one of these strains or varieties have been planted extensively and in the same field and even the same row. It is not impossible that such may have furnished a basis for cross-fertilization.

But returning to a consideration of the planting of seedlings, it will be seen that whatever possibilities of cross fertilization may normally exist have been increased many thousand fold by the planting of the thousands of different seedling varieties in the immediate vicinity of commercial plantings.

A third possible cause that has been suggested is, that laborers have unwittingly collected propagating material from plantings of seedlings which very often are seedy. This does not seem to me to be a very probable explanation, for two reasons. First, such seedlings have always been planted at least in separate rows and usually in separate blocks and their location has been well known by those who direct the collection of planting material. Second, they

are so different and so varied as to scarcely escape the attention even of ordinary laborers, while those who do this work have had some training in selection.

A fourth possible explanation is to be found in a combination of the first and the second. A bud-mutation may have occurred affecting not the pollen and its effectivity upon its own flower but rather the form of the flower. The pineapple flower, because of its shape, is much less subject to cross-pollination than many other flowers. Even at its maturity the flower of the Cayenne pineapple is tubular and only slightly opened, while the anthers and sitgma are not close to the opening of the corolla but rather protected and hidden by this organ. A mutation affecting only slightly the form of the flower might render it more open and more susceptible to cross-pollination. If such a mutation occurred it also would be multiplied, and if at the same time many varieties with fecundating pollen were in proximity an increase in seediness might be expected.

Of these four possible causes of increased frequency of seed occurrence, the first two appear to be the more probable, the third of very doubtful influence, and the fourth requiring more study of the flowers to see whether any such differences as suggested, or others, do exist, before the significance of this factor can be appraised.

REMEDIES

In so far as these four factors singly or combined may be responsible for the increased seediness, the remedies suggest themselves. If there have been bud-mutations involving the character of self-fertility, it will be possible to overcome the difficulty only by eliminating such plants from the plantations. This will not be an easy task since, as already indicated, the condition of seediness is not discovered until the identity of the plant from which the fruit came has been lost. A very careful study should be made to determine whether there are any external characters of plant or fruit which are correlated with the self-seeding character. Certain unit characters in plants are known to be linked with other characters and this fact is often of great aid to the plant breeder. In this case if there is a visible external character that is linked with the hidden character of seediness, then it would be possible to quickly eliminate any trouble that may have arisen from such a mutation. All plants exhibiting such correlated character could be destroyed or discarded from propagating material. But it may require a great deal of study to determine any such correlation as may exist.

This much seems certain, that any seediness which is due to the self-fertility of the flowers is likely to be perpetuated indefinitely through vegetative propagation if such plants are allowed to furnish planting material. Therefore it would be safest to discard as planting stocks all seed-producing plants that can be found without stopping to determine whether the seedy condition in that particular case is due to the self-fertility of the pollen or to cross-pollination.

Let us turn now to the means of overcoming the effects of cross-fertilization as a cause of seediness. Here it is to be remembered that the effects of the foreign pollen are upon the flower and fruit only, and in no way does such pollen affect the rest of the plant. Hence the trouble is not self-perpetuating and will be eliminated as soon as the fecundating varieties are destroyed or segregated. Therefore no alarm is to be entertained about the future results of the thousands of seedlings that have been planted, provided that they are not used in vegetative propagation and allowed to become mixed with commercial plantings before

their characters are studied. They may cause some seedy fruit while they are being tested but when destroyed their effects cease. Because of the probable influence of their pollen in effecting seed formation in the Cayenne variety or varieties, and because of the possibility of laborers collecting planting stock from them, it would be advisable to segregate all seedlings from commercial plantings during the period of testing. This does not mean anything like a quarantine but merely a separation. In fact some light might be thrown upon this subject by the planting of a few rows of Cayenne among the experimental plants and examining the fruits for seed at harvest time.

Such varieties of seedlings as may be found to have promise for commercial plantings should be studied as to their power to fertilize the flowers of the standard variety or varieties before they are adopted for general planting. Such study might include a test of the pollen of each upon the other where artificially applied and also a close observation of the two when planted side by side but not hand pollinated. If any new variety should prove to be an effective pollinizer of the existing commercial varieties when planted near by this fact would argue strongly against the adoption of the new variety unless it were used for entirely separate plantings.

In this connection also it is to be noted that a new variety otherwise of great promise, should not be condemned and discarded because of its seedy character until the self-fertility of its flowers has been tested. Its seedy condition may be due to cross-pollination. This test can easily be made by bagging to protect the flowers from foreign pollen.

As a further study of the effects of cross-pollination in relation to the present occurrence of seeds, it would be desirable to determine what may be the effects of the pollen of any of the strains or varieties now passing under the name of Cayenne when such pollen is applied to the stigmas of another of these forms so often found near by.

A third hypothetical cause of increased frequency of seed occurrence has been stated to be the possible unintentional use of seedlings in commercial plantings. One measure to be taken to overcome any possible effects of this character has been referred to above, namely, the removal of all such seedlings to an experimental plot by themselves where they would be entirely free from the danger being used for general plantings. In case any of the planters that have grown seedlings have been careless in this matter in the past, the records would probably show where plants from a certain field were set. An examination of such new fields would reveal whether the accident had occurred for there would be entirely new types scattered among the standard sorts. These new types could be destroyed and if it seemed probable that seedlings approaching the standard forms in appearance were also in these fields, the entire field or block could be condemned as a source of further planting material but could be continued for its fruit production throughout as many ratoon crops as usual.

Now may be considered the remedies for any effects that may arise out of the fourth cause which has been stated to be a possible combination of bud-mutation and cross-fertilization. If in any plant or plants a change has arisen which renders the flowers more susceptible to cross fertilization, such mutation might be more easily detected than a change in the character of the pollen. The

possibility of some such change in the formation of the flower having taken place should be kept in mind as a part of the problem to be studied.

In conclusion, it may be said that, without careful study of the problem in the field, it is impossible to state with certainty the causes of increased frequency of seed occurrence but bud-mutation and the increased probabilities of cross fertilization seem to be the most probable influences at work. If this be the case the elimination of the mutants should be attempted and the segregation of the numerous varieties under trial should be made effective as soon as possible. At the same time it is to be remembered that the effects of pollinizers are not far-reaching and self-perpetuating as would be the case with mutants, the evil effects of which are cumulative. Finally, further studies should be made of pollen and of cross-pollination in the pineapple.

PRAYS CITRI MILLIERE, A RIND INSECT PEST OF PHILIPPINE ORANGES[1]

By José Mañalac San Juan

WITH TWO PLATES

INTRODUCTION

There are numerous insect enemies of Citrus in the Philippine Islands. Among these, *Prays citri* Milliere is important because it damages a large amount of fruit. Although so harmful, little attention has been given this pest in this country.

IMPORTANCE OF THE PEST

Prays citri does considerable damage to Philippine pummelos and oranges (lucbans and cajeles), reducing the production and in many cases preventing the development of the fruits. Attacked fruits which may succeed in maturing become unsightly and unsalable owing to the numerous galls in the rind. Unless proper steps are taken to prevent the injury, the value of Philippine Citrus production will continue to suffer great losses every year.

HISTORICAL

The adult was first described by Milliere (1) in 1873 as *Acrolepia citri*, but later the species was transferred by the same author to the genus *Prays*.

In 1907 the same moth was described by Meyrick (1) as *Prays nephelomima*, this author having apparently overlooked Milliere's older species. Meyrick's species is therefore a synonym of *Prays citri*.

In 1913 Essig (2) published a short paper in which he mentioned that the larva of the moth is a serious pest of Philippine oranges. The materials used in this publication were furnished by C. F. Baker, Dean of the College of Agriculture, at Los Baños, Philippine Islands.

In 1914 Quayle (3) reported that the larva of this small moth causes serious damage on the blossoms of oranges and lemons in Sicily and in some less important Citrus sections of Italy. In Messina a large percentage of the blossoms and newly formed fruits were destroyed in 1913.

In 1916 Fletcher (4) recorded *Prays citri* as an injurious pest of oranges and other species of Citrus in Southern Europe. It is known to occur in India, Ceylon, New South Wales, and the Philippines.

OBJECT OF THE PRESENT WORK

The object of the present work was to study the life history, habits, and the extent of damage caused by *Prays citri* on Philippine Citrus fruits, and to devise effective methods of control.

The work was begun in April, 1922, and was continued until February, 1923, in the College of Agriculture. Life history studies were conducted from July, 1922, to January, 1923, partly in the Insectary of the Department of Entomology and partly in the Citrus Orchard of this College.

[1] Thesis presented for graduation, with the degree of Bachelor of Agriculture, from the College of Agriculture, No. 165; Experiment Station contribution No. 212. Prepared in the Department of Entomology under the direction of Assistant Professor L. B. Uichanco.

EXPERIMENTAL RESULTS AND DISCUSSIONS

LIFE HISTORY

Methods of study.—Infected fruits were collected and confined in glass jars, with the tops covered with cheese cloth. The larvæ when ready to pupate crawled out of the galls and fastened themselves by a loosely woven cocoon on the glass wall, on the rind of the fruit or on other solid objects. The adults after emergence were transferred to another glass jar and here allowed to mate. Each couple was then isolated in a separate receptacle and fresh flowers, young fruits of the host plants, and a piece of cotton moistened with diluted honey were supplied every day. Examination was made daily for eggs and when these were found they were transferred to flower buds, matured open flowers, and young fruits of the food plants in the Citrus Orchard. The experimental materials in the orchard had previously been covered with bags made of paraffin paper to protect them against contamination from outside sources. Daily observation was made during the incubation period.

Egg.—The egg (Plate I, fig. 1) is sub-elliptical, slightly tapering toward one of the poles. It measures 0.2 millimeter in length and 0.12 millimeter in its largest cross sectional diameter. Freshly laid eggs vary in shade from almost colorless to light yellow, becoming darker as they approach the end of the incubation period. Eggs were laid singly, usually at night, and generally on young fruits, although occasional oviposition was observed on flowers. On account of their small size the eggs are very difficult to find even with the aid of a hand lens. The eggs used in the present breeding work were laid during the nights of August 30 and 31, and September 1, 1922.

As shown in Table I, twenty-two eggs were laid by four moths in the Insectary during three successive nights. This number gives an average of approximately two eggs for a moth in one night. Definite data on the total number of eggs laid by one female were not obtained. The incubation, as shown by the same table, was from six to twelve days, with an average of 8.36 days.

As to place of oviposition, it was noted in the present experiments that eggs were most frequently deposited on newly formed fruits, and rarely on flowers. Fletcher (1), speaking of the same Citrus pest in India, and Quayle (3), in the Mediterranean region, however, maintain that the moths oviposit on calices or on flower peduncles.

Larva.—The larva on hatching (Plate I, fig. 2) is white, with a light brownish-yellow head. The segments are well marked. As it grows older, the color becomes first whitish yellow and later, in the full grown larva, light green; the head becomes dark chocolate brown.

The full grown larva (Plate I, fig. 3) has thirteen distinct segments, exclusive of the head; and measures from 4.2 to 5.5 millimeters in length and rarely more than 1.5 millimeters in cross-sectional diameter at its broadest segment. There are three pairs of thoracic legs and five pairs of prolegs. The body is subcylindrical, slightly tapering posteriorly, semitransparent, and sparsely set with fine hairs, which are not visible to the naked eye. The terminal anal segment bears the last pair of prolegs.

The lateral margin of the pro-, meso-, and metanota bear a small subcircular dark chocolate spot. In the mesonotum is a second elongate smaller marking located entally near the first on each lateral margin. Each of the larger spots

measures about 0.09 millimeter in diameter, the smaller 0.09 millimeter long and 0.45 millimeter wide. The abdominal tergites bear a thin brownish red line measuring 0.17 millimeter extending to the lateral margin on either side. This line is lighter in color anteriorly and becomes increasingly darker posteriorly.

The young larva upon hatching bores into the rind and eats the underlying soft tissue. The entire feeding period is spent inside the cortex and when the larva is full grown, it goes out into the open, ceases feeding for a time, and then pupates.

The total length of the larval stage, as shown in Table I, varies from 49 to 58 days, with an average of 53.36 days.

Pupa.—The pupating larva decreases in length due to the contraction of the body. The larva encloses itself in a loosely woven silk cocoon and pupates in this condition. The anal extremity of the pupa is fastened on the host by means of fine silk thread. The pupa (Plate I, fig. 4) measures from 4.8 to 5.5 millimeters long, rarely more than 6 millimeters, and 0.9 to 1.2 millimeters in diameter at its broadest segment. Its body tapers posteriorly. The wings, proboscis, antennæ, and legs are folded close to the body, the apices of the first three reaching the fifth abdominal segment. Eyes are subglobular, each measuring 0.25 millimeter in diameter.

The following data show the daily changes in color of the pupa. The description is based on ten specimens.

> *First day.*—The newly formed pupa is light green; a median subelliptical longitudinal blotch, usually light red and diffused toward the border, extending from the mesonotum to about the fourth or fifth abdominal tergite. The eggs are light brown.
>
> *Second day.*—General color is darker; dorsal blotch beginning to disappear.
>
> *Third day.*—Color still darker. Head, ventral portion of the body between the wings, legs, antennæ and abdominal cauda, brownish green. Eyes light brown.
>
> *Fourth day.*—Light chocolate brown. Abdominal cauda pale yellowish brown. Eyes black.
>
> *Fifth day.*—General color, dark chocolate brown, more darkly so ventrally between the appendages. Head also darker. Eyes black. Abdominal cauda, light chocolate brown.
>
> *Sixth day.*—Adult.

During the progress of the present work, pupæ of this moth were found on the surface of the fruit, usually on crevices in the skin, in the sheltered portions of the leaves, and at the junctions of the twigs and branches. The pupal stage under laboratory conditions, as shown in Table I, varies from four to six days.

TABLE I.—*Life history of Prays citri.*

No.	Eggs. Laid.	Eggs. Hatched.	Eggs. Incubation period.	Pupated.	Length of larval stage.	Moths emerged.	Length of pupal stage.	Total length of immature stages.
			days		*days*		*days*	*days*
A_1	30-VIII-22	6-IX-22	7	27-X-22	51	1-XI-22	5	63
A_2	30-VIII-22	5-IX-22	6	d				
A_3	31-VIII-22	6-IX-22	6	25-X-22	49	29-X-22	4	59
A_4	31-VIII-22	6-IX-22	6	2-XI-22	57	7-XI-22	5	64
A_5	31-VIII-22	a						
B_1	30-VIII-22	10-IX-22	11	31-X-22	51	5-XI-22	5	67
B_2	1-IX-22	9-IX-22	8	3-XI-22	53	6-XI-22	5	66
B_3	1-IX-22	9-IX-22	8	1-XI-22	53	6-XI-22	5	66
B_4	1-IX-22	a						
B_5	1-IX-22	10-IX-22	9	d				
B_6	31-VIII-22	9-IX-22	9	2-XI-22	53	7-XI-22	5	67
B_7	31-VIII-22	a						
C_1	31-VIII-22	8-IX-22	8	31-X-22	53	5-XI-22	5	66
C_2	31-VIII-22	8-IX-22	8	31-X-22	53	5-XI-22	5	66
C_3	31-VIII-22	a						
C_4	1-IX-22	a						
D_1	30-VIII-22	a						
D_2	30-VIII-22	11-X-22	12	8-XI-22	58	14-XI-22	6	76
D_3	31-VIII-22	10-X-22	10	d				
D_4	1-IX-22	a						
D_5	1-IX-22	a						
D_6	1-IX-22	10-IX-22	9	5-XI-22	56	10-XI-22	5	70
Minimum.			6		49		4	59
Maximum			12		58		6	76
Average			8.36		53.36		5	66.33

a—eggs remained unhatched.
d—larvæ dead; date not determined.

Table I further shows that the duration of the immature life of the moth varies in the laboratory from 59 to 76 days, with an average of 66.36 days. Likewise, it may be noted that the incubation period lasts from 6 to 12 days, with an average of 8.36 days; larval stage 49 to 58 days, with an average of 53.36 days; and pupal stage, 4 to 6 days, with an average of 5 days.

Adult.—The moth ranges in size from 3.6 to 4.5 millimeters long, with a wing expanse of from 8.4 to 10.2 millimeters. The general color is grayish brown.

The head is light brown, measuring 0.66 millimeter in width. The eyes are black, subglobose, measuring 0.25 millimeter in diameter. Antennæ grayish brown, tapering slightly toward the tip; average length 3.42 millimeters.

The thorax is covered with light brown scales; wings long and narrow, having a broad fringe particularly on the hind wings. Fore wings bear numerous irregular markings which are distributed over the wings; a conspicuous marginal fringe from the apex extending over the distal half of the anal margin. Hind wings membranous, light gray, without spotting, and with marginal fringe on the costal, apical, and outer anal margins. The fore wings measure about 4.6 millimeters long and about 1.3 millimeters wide; the hind wing, about 3.5 millimeters long and 1.2 millimeters wide. Fore and middle legs concolorous with fore wings, stout, shorter than metathoracic pair; the last light brown, measuring about 4 millimeters long.

The abdomen concolorous with the head (except eyes and antennæ), and thorax; from 2.8 to 3.2 millimeters long and rarely a millimeter wide across the broadest segment.

Table I shows the life history of the moth, observations on which were carried under laboratory conditions. Four pairs, designated as A, B, C, and D, were used in this breeding experiment.

A laid eggs A_1, A_2, A_3, A_4, A_5
B laid eggs B_1, B_2, B_3, B_4, B_5, B_6, B_7
C laid eggs C_1, C_2, C_3, C_4
D laid eggs D_1, D_2, D_3, D_4, D_5, D_6

HOST PLANTS

Apparently the insect feeds on all species of Citrus, although oranges and lemons are its favorite host plants. The pest has not been recorded from any other plant genera. The writer succeeded in rearing adults from larvæ found in the rind of the following species of citrus fruits, collected from the College Citrus Orchard and from the neighboring barrios (San Antonio, Maajas, Anos, Mayondon, and Bayog).

1.	*Citrus sinensis* Osbeck. . .	cajel.
2.	*Citrus decumana* Linn. . . .	lucban.
3.	*Citrus aurantifolia* Swingle .	lime.
4.	*Citrus medica* Linn. . . .	citron.
5.	*Citrus limonia* Osbeck .	lemon.
6.	*Citrus hystrix* DC. . .	sour orange (unwrinkled variety).

HABITS

The larvæ of *Prays citri* live just beneath the rind next to the pulp. During the feeding period the larva makes a gall in the rind, appearing externally as a tumor-like swelling. The tissue inside the rind is eaten and as the full-grown larva comes out, it eats its way through, leaving a tunnel which opens at the surface. In severe cases 20 to 30 galls, or even more, may be found on the surface of the fruit. In cases where the galls are very numerous the entire surface of the fruit may be covered. These galls are very prominent and oftentimes mar the appearance and affect the keeping qualities of the fruits; the openings furnish excellent germinating places for fungi and shelter for mealy bugs.

Fletcher (1) (4) (5) in India and Quayle (3) in the Mediterranean regions reported that the larvæ upon hatching bore through the interior of the flowers which are destroyed; pupation, according to these authors, usually occurs within the flowers and also in protected places on the leaves or junctions of the twigs and branches. These reports in regard to feeding of larvæ and pupation occurring in flowers have not been confirmed by the writer's observations The pupation on the leaves and junctions of the twigs was corroborated.

The moth generally flies at night and is attracted to light to some extent. The adults under confinement were found to be inactive during the day. They rested under cover. These adults were observed to live as long as eighteen days, from August 28 to September 14, 1922.

EXTENT OF DAMAGE

Investigations were carried on during August and September, 1922, on the infestation of Citrus fruits by the larvæ of *Prays citri* in the College Citrus Orchard and in the neighboring barrics of San Antonio, Maajas, Anos, Mayondon, and Bayog of the municipality of Los Baños.

The number of fruits in a tree, as given in Table II, were counted and the number of infested fruits recorded. From these data the percentage of infestation was calculated.

As shown in Table II, six species of Citrus were infested by the pest. Of these *Citrus sinensis* appears to be the most susceptible, the degree of infestation ranging from 78.23 per cent to 84 per cent; *Citrus decumana* ranks second, with an infestation of from 45.45 per cent to 83 per cent; third, *Citrus aurantifolia*, from 60 per cent to 68.58 per cent; fourth, *Citrus medica*, from 0 per cent to 66.66 per cent; fifth, *Citrus limonia*, from 3 per cent to 7.14 per cent, and sixth, *Citrus hystrix*, from 0 per cent to 4.54 per cent.

TABLE II.—*Percentage of infestation of fruits on individual trees.*

Citrus spp.	Number of fruits counted on the tree.	Number of fruits attacked.	Percentage of infestation.	Locality.	Date.
Citrus decumana....	16	8	50	C. A. Citrus Orchard....	20–VIII–1922
(lucban)	10	6	60	C. A. Citrus Orchard....	20–VIII–1922
	22	10	45.45	C. A. Citrus Orchard....	20–VIII–1922
	52	34	65 38	Bayog............	24–VIII–1922
	28	16	57.14	Bayog............	24–VIII–1922
	15	11	73 33	San Antonio. ...	5–IX–1922
	8	6	75	San Antonio.......	6–IX–1922
	35	28	80	Maajas........ ...	6–IX–1922
	18	15	83.33	Mayondon. .	14–IX–1922
	42	33	78.5	Mayondon.	14–IX–1922
	8	5	62.5	Anos.	2–IX–1922
Citrus sinensis	80	65	81.25	San Antonio.... .	3–IX–1922
(cajel)	50	42	84	Anos.	3–IX–1922
	155	120	78.23	Los Baños (proper).	17–IX–1922
Citrus aurantifolia ...	296	203	68.58	C. A. Citrus Orchard.	18–IX–1922
(lime)	184	110	60	C. A. Citrus Orchard...	18–IX–1922
Citrus medica. ...	3	1	33.33	C. A. Citrus Nursery...	23–VIII–1922
(citron)	3	2	66 66	C. A. Citrus Nursery...	26–VIII–1922
	2	0	0	C. A. Citrus Nursery. .	26–VIII–1922
	5	1	20	C. A. Citrus Nursery.	26–VIII–1922
Citrus limonia . .	50	2	4	C. A. Citrus Orchard.	6–IX–1922
(lemon)	42	3	7.14	C. A. Citrus Orchard. .	6–IX–1922
	67	2	3	C. A. Citrus Orchard.. .	6–IX–1922
Citrus hystrix. .	22	1	4.54	C. A. Citrus Orchard...	2–IX–1922
(unwrinkled variety)	18	0	0	C. A. Citrus Orchard. .	2–IX–1922

In order to determine the extent of injury on individual fruits of the six species named, a number of infested fruits of each species was carefully examined. Table III gives the number of swellings or galls on individual fruits.

TABLE III.—*Extent of injury on individual fruits.*

Citrus spp.	Number of attacked fruits examined.	Number of swellings.	
		Maximum.	Minimum.
Citrus decumana.	5	25	8
(lucban)	10	28	3
	10	20	6
Citrus sinensis	20	32	4
(cajel)	10	23	6
	10	12	5
Citrus medica	3	5	3
(citron)	4	6	3
	4	5	2
Citrus limonia.........	5	3	1
(lemon)	5	4	1
	5	3	2
Citrus hystrix...........................	2	2	1
(unwrinkled variety)	2	1	1
	2	1	1

According to Table III, the largest number of galls was found on *Citrus sinensis*, from 28 to 30; second, *Citrus decumana*, 20 to 28; third, *Citrus aurantifolia*, 12 to 15; fourth, *Citrus medica*, 5 to 6; fifth, *Citrus limonia*, 3 to 4; and the smallest on *Citrus hystrix*, 1 to 2.

DISTRIBUTION

Prays citri, originally described from Southern Europe (1) (3) (4) (5) (6), is now known to occur in New South Wales, India, Ceylon, Italy, Sicily, Southern France, Corsica, Canary Islands, Eastern Australia, and the Philippines.

In the Philippines, according to Prof. C. F. Baker and Prof. H. E. Woodworth, formerly of this College, the insect is found in the northern provinces; Mindoro and Batangas; and the writer found it in Bulacan, Nueva Ecija, Rizal, and Laguna; probably it may be found in other provinces where *Citrus decumana* and *Citrus sinensis* are grown. Prof. J. E. Higgins of this College has noted it in the province of Bukidnon, Mindanao, so that its distribution is general throughout the Archipelago.

TABLE IV.—*Relation of abundance of Prays citri to the fruiting seasons of Citrus decumana*

Months of the year.	Conditions and extent of fruiting.	Degree of abundance or scarcity of the larvæ.	Remarks
January	Flower buds beginning to appear; in others, half matured fruits	Fairly abundant	Galls mostly unopened
February	Flowering continuous; young fruits beginning to develop; few matured fruits	Scarce	A large number of galls opened
March	Flowering continuous to less extent; young fruits in abundance; few matured fruits	Beginning to be abundant	A large number of galls opened; galls on young fruits not yet distinct
April	No flowers; young and half matured fruit abundant	Abundant	Galls more prominent on young fruits
May	Maturing and matured fruits; harvest time	Abundance declining	Many galls are opened
June	Matured fruits; end of harvest time	Very scarce	All galls practically opened
July	Flowering to less extent than in previous season	Larvæ beginning to appear in small numbers	No mature fruits
August	No flowers; young and half matured fruits less abundant than in previous seasons	Abundant	Galls mostly unopened
September	Matured fruits; harvest time	Beginning to be scarce	Many galls are opened
October November	No flowers nor fruit	Very scarce or none at all	Not season for lucban
December	Few flower buds appearing; few young fruits	Very scarce, but occur to limited extent	Beginning of heavy fruiting season

SEASONAL OCCURRENCE

In Los Baños the insect breeds during the fruiting season of Citrus. Whenever the trees, especially *Citrus decumana* and *C. sinensis*, are in fruit, larvæ of the moth are found. In order to determine the relation between the abundance of the larvæ to the appearance of fruits of Citrus, observations were made particularly on *Citrus decumana* for a period of one year. The results are given in Table IV.

As Table IV shows, young and half-matured fruits are abundant during April, May, and August; at that time also, *Prays citri* larvæ are found in abundance. From October to December lucban is practically out of season and the larvæ are correspondingly scarce. The table further shows that in January there is a number of half-matured fruits, and the larvæ then are relatively abundant; in February when fruits are maturing and the majority of galls are open, the larvæ again begin to become rather scarce. In March when fruits are produced in large numbers, the larvæ are numerous, as shown by the prevalence of the galls. On the other hand, the larvæ are very rare in June when all galls are practically opened, and continue to be scarce until July, about which time they begin to become abundant again.

CONTROL MEASURES

Not much was done in the present work in the study of the methods of control of the pest. It was the original plan in the earlier part of this study to conduct fumigation experiments on a few blooming and fruiting trees, but the plan had to be postponed for a later investigation. However, spraying with oil emulsion was carried on during August, September, and December, 1922, and January, 1923, on the Citrus Orchard in co-operation with the Department of Agronomy. The spray was not intended primarily for *Prays citri*. The results, however, appeared to be promising and the control of the insect by oil emulsion is worth further study. The insects were most susceptible to the spray during the pupal stage.

Various investigators have suggested that spraying is the only artificial measure that may be employed. Brigante (4), on the basis of his investigation in the province of Salermo in 1912, states that the larvæ of *Prays citri* on the blossoms may, if necessary, be killed by a one per cent solution of lead arsenate. Cimatti (7) in 1913, writing in Italy, gave the following spray formula for the larvæ of *Prays citri* which ruin the orange blossoms: 20 gal. water, 22 lb. molasses, 22 lb. dregs of lime juice essence and 2 gal. water in which 4½ of sodium arsenate have been dissolved.

SUMMARY AND CONCLUSIONS

1. *Prays citri* Milliere is one of the most destructive insect enemies of Citrus in the Philippines. The insect belongs to the family Tineidæ, order Lepidoptera.

2. The eggs are laid singly at night, most frequently on young fruits; rarely on flowers. They are subelliptical, measuring 0.2 millimeter long and 0.12 millimeter in cross-sectional diameter; they vary in shade from almost colorless to light yellow, when newly laid; darker at the end of the incubation period.

3. The full-grown larva measures from 4.2 to 5.5 millimeters long; rarely over 1.5 millimeters across its broadest segment. The body is subcylindrical,

slightly tapering posteriorly, semitransparent and sparsely set with fine hairs. Each abdominal tergite bears a thin red line extending to the lateral margin.

4. The pupa is inclosed by a loosely woven silk cocoon and measures from 4.8 to 5.5 millimeters long; rarely more than six millimeters; from 0.9 to 1.2 millimeters wide at its broadest segment. When newly formed it is light green but becomes dark chocolate brown when mature. Pupæ are found on the surface of the fruits, in the sheltered portions of the leaves, and at the junctions of the twigs and branches.

5. The adult is light grayish brown and measures from 3.6 to 4.5 millimeters long with a wing spread of from 8.4 to 10.2 millimeters; wings long and narrow with marginal fringe particularly on the hind wings.

6. The total duration of immature stages varies from 59 to 76 days; incubation period, 6 to 12 days, average, 8.36 days; larval stage, 49 to 58 days, average, 53.36 days; pupal stage, 4 to 6 days, average, 5 days.

7. The larvæ feed on the following species of Citrus:

1. *Citrus sinensis* Osbeck. (cajel)
2. *C. decumana* Linn. (lueban)
3. *C. aurantifolia* Swingle. (lime.)
4. *C. medica* Linn. (citron)
5. *C. limonia* Osbeck. (lemon)
6. *C. hystrix* DC. (sour orange, unwrinkled variety)

8. The larva is a rind feeder. It lives beneath the surface of the rind next to the pulp, producing tumor-like swellings on the surface of the fruit. These galls are very prominent and are opened when the full-grown larvæ are ready to crawl out and pupate. Pupation takes place on the outer surface of the fruit, on protected portions of the leaves, and at the junction of the twigs and branches. The adults are active at night. Under confinement, adults were found to live for eighteen days.

9. The degree of infestation on the six species of Citrus studied varied greatly; the following species are arranged in the order of their susceptibility: *Citrus sinensis, C. decumana, C. aurantifolia, C. medica, C. limonia, C. hystrix.*

10. The insect breeds during the fruiting season of Citrus, and whenever *Citrus decumana* and *C. sinensis* are in fruit, the larvæ of the pest are found. The larvæ are abundant during April, May, and August, and scarce from October to December.

11. No natural enemies of the insect were observed in the course of the present investigations.

12. Oil emulsion has been found efficacious in killing the insect in the pupal stage.

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ILLUSTRATIONS

(Magnifications given refer to sizes of original figures)

Plate I.

Fig. 1—Egg. × 185
2—Newly hatched larva, dorsal view. × 20
3—Full grown larva, lateral view. × 20
4—Pupa, ventral view. × 20
5—Adult, dorsal view. × 17

Plate II

Pupæ on leaf of *Citrus aurantifolia*

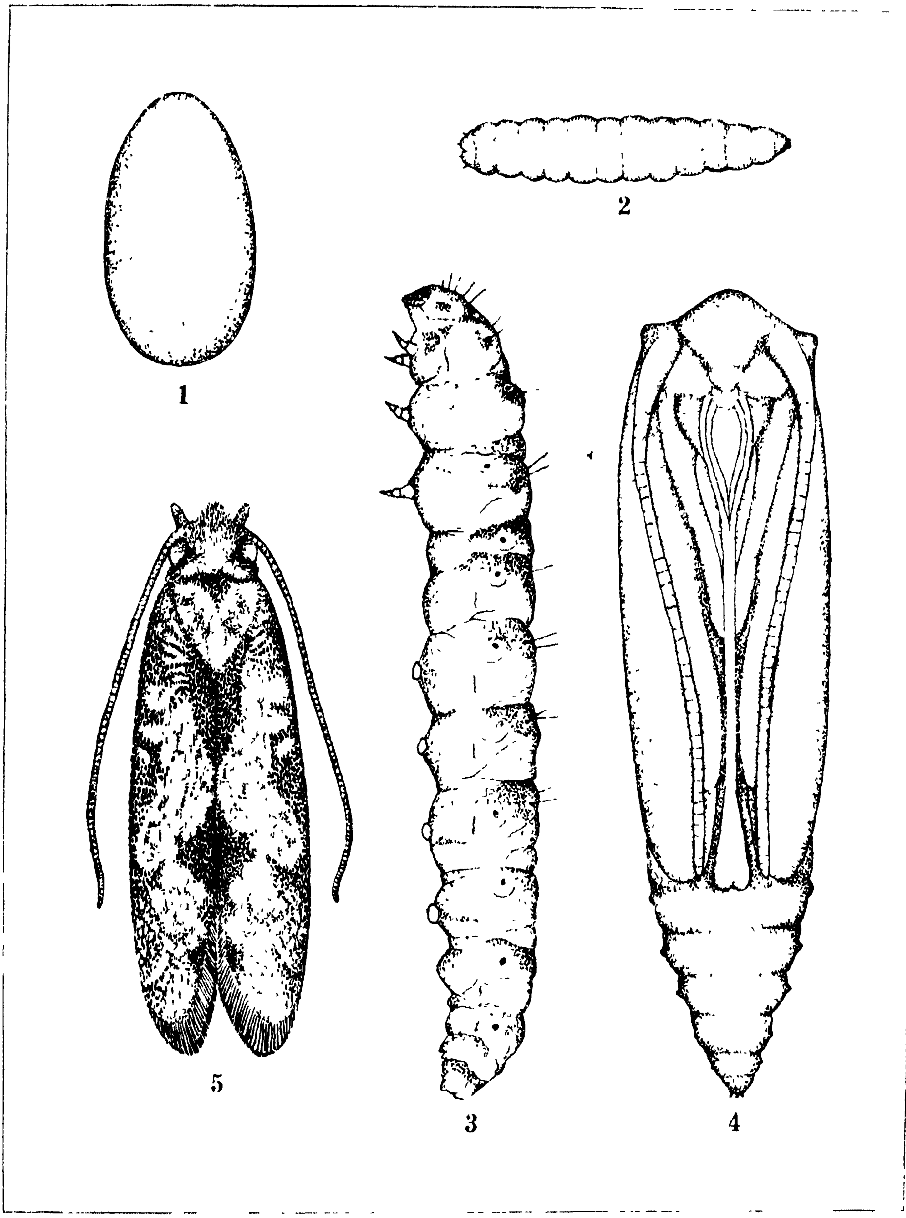

PLATE I

PLATE II

THE EFFECT OF AGE ON THE HATCHING QUALITY OF EGGS[1]

By MARTIN O LEONCIO

Popular knowledge on the subject of the effect of age on the hatching quality of eggs is very meager in the Philippines as it is a very common practice to set eggs of different ages. And as there has been no investigation on the subject in this College, no Philippine data or literature can be cited.

Though conditions in the Philippines are very different from conditions in the United States, a review of the literature on the subject of incubation in that country may furnish us some valuable information on this subject. Lamson, Jr., and Kirkpatrick (1) working on the effect of age on the hatchability of eggs, found that a greater number of chicks could be obtained from younger eggs than from older ones. Out of 590, 3 to 5-day old eggs set, they obtained 60 per cent hatch, and from 531, 11 to 12-day old eggs, only 52 per cent hatch. Considering only the fertile eggs, they obtained 71 per cent hatch from the younger eggs and 63.5 per cent from the older ones. From these results they concluded that two weeks may be considered the time limit for holding eggs for hatching On the same line Waite (2) obtained the results given in the following tabulation.

Age of eggs	No. of eggs set.	No. of eggs fertile	No of eggs hatched	Per cent of eggs hatched. From all eggs.	Per cent of eggs hatched. From fertile eggs
Fresh	1261	1200	774	61 38	64 50
5-day	2054	1942	1321	64 31	68 02
10-day	1127	1043	586	51 99	56 02
15-day	499	451	207	41 48	45 89

He observed that the percentage of eggs not hatching showed a fairly consistent increase for all periods longer than one week. He also states that two weeks may be considered, generally, as the longest time under the very best conditions for holding eggs for hatching.

Relative humidity and temperature of the atmosphere are external factors that also have something to do on the hatching quality of eggs. Dryden (3) conducted three sets of experiments, in the first of which the eggs were subjected under an average relative humidity of 48.7 per cent, in the second, the eggs were placed under an average relative humidity of 55.3 per cent, and in the last set he had the eggs under a relative humidity of 64.7 per cent. The average relative humidity of the room where the incubators were operated was 73.4 per cent. The best results were obtained from the second set where the eggs were subjected under medium conditions. Dryden also conducted another experiment along

[1] Thesis presented for graduation from the College of Agriculture, No 166, Experiment Station contribution, No. 213

Prepared in the Department of Animal Husbandry under the direction of Mr Mariano Mondoñedo and Dr F. M Fronda

the same line except that the average relative humidity of the room was only 45.5 per cent. He obtained the best results from eggs that were given a maximum supply of moisture which had an average relative humidity of 55.5 per cent.

The present work was undertaken to carry out under Philippine conditions some of the recommendations of the American workers cited. The objects of the work were:

(1) To determine the time limit of holding hatching eggs under Philippine conditions.

(2) To determine the best age to set eggs in order to produce the maximum number of chicks at a comparatively small expense.

(3) To determine which season of the year is the best to hatch eggs.

The experiment was started in December, 1921, and ended in August, 1922. It was conducted in one of the poultry houses of the College of Agriculture, University of the Philippines, at Los Baños.

MATERIALS AND METHODS

Observations were made on the eggs of the Cantonese and the Barred Plymouth Rock breeds. The eggs were selected from the eggs produced by the flocks of the Animal Husbandry Department of the College of Agriculture. Natural incubation was used in hatching the eggs, and hens belonging to this department were utilized for this purpose. Before a suspected broody hen was given eggs for hatching, preliminary tests were made by placing several old eggs under this hen in the evening, and the next morning, if she proved to be really broody, twelve selected eggs were given her to hatch.

The eggs used were uniform in size, shape, and shell texture. They were kept in a cool, dry, well ventilated box. Before the selected eggs were placed under a broody hen they were properly labeled with their age in red ink. Three fresh-eggs, three five-day old eggs, three ten-day old eggs, and three fifteen-day old eggs were set under each hen. The eggs were tested on the seventh day and on the fourteenth from the time they were placed under the hen.

Nests, made of petroleum boxes, 140 centimeters long, 85 centimeters wide, and 85 centimeters high, were used. The sides were provided with holes for ventilation. Excelsior was used as nesting material. The nest was made slightly deeper at the center than around the edges to prevent the eggs from rolling from under the hen and becoming chilled.

The setting hens were provided with grains of corn and rice, and fresh water was available all the time. They were fed twice every day, morning and afternoon. They were taken out of their nests one by one, and, after about twenty minutes, they were put back on their nests. On the nineteenth day of incubation, the setting hens were not allowed to come out for food and water. A wallow box, containing two parts of dust and one part of lime was provided in the hatching room for the hens to dust themselves.

The weather records used in this work were obtained from the Department of Botany of the College of Agriculture. The time during which the experiment was carried on was divided into three periods. In the first period, the months of December, January, and February, being the coldest, were included. The second period included in the hottest months of the year, March, April, and May, and in the third were included the months of June, July, and August which are the medium months of the year.

RESULTS

The results obtained in this experiment are given in Tables I, II, and III. Table I gives the results with the Cantonese eggs, Table II with the Barred Plymouth Rock eggs, and Table III both Cantonese and Plymouth Rock. In these tables the per cent of infertility was obtained by dividing the number of infertile eggs determined during the first testing by the total number of eggs set, and multiplying the quotient by one hundred. The "dead" includes the eggs that were found dead during the first and second testings, and those eggs that failed to hatch, and the per cent "dead" was obtained by dividing the sum of all those "dead" by the number of fertile eggs in the setting and multiplying the quotient by one hundred. The number of chicks obtained was divided by the total number of eggs and the quotient multiplied by one hundred to get the per cent hatched from all eggs; and to get the per cent hatched from fertile eggs, the number of chicks obtained was divided by the number of fertile eggs only and the quotient multiplied by one hundred.

DISCUSSION OF RESULTS

As may be seen in Tables I and II, the results obtained in both breeds were practically the same. Without exception, the per cent of infertile eggs increased as the length of holding the eggs previous to incubation increased. It is to be regretted that no provision was made to determine during the first test which of these eggs were infertile and the fertile eggs that had started to develop but had died before the change could be noticed through candling. It is very probable in eggs that were kept ten and fifteen days their germ spots started to develop and died before they were placed under the setting hen.

It may also be noted that the per cent of "dead" increased as the age of the hatching eggs increased. This is true in both breeds and in the different periods of the year. The germs that survived till the eggs were set undoubtedly possessed strong vitality at the start, but after having been subjected to the conditions present during the time of holding them, they probably weakened and as a result there were more "dead" in the older eggs than in the younger ones. In both breeds, the per cent of "dead" was less during December, January, and February than during the other two periods in which the per cents were about the same. These differences may have been due to the condition of the birds at the time the eggs were laid. During the months of December, January, and February the birds were probably in a much better condition than during either of the other two periods, as it is medium temperature during these three months and there is always fresh green grass which the birds can get readily, in the leaves of which there is protein.

The per cent of hatchability is the same in both breeds, being highest with the fresh eggs and decreasing as the time of holding the eggs previous to incubation increases. These results may be expected as the longer the eggs are kept before hatching the more moisture evaporates from them, and some changes that are injurious to the germ spot inside the egg takes place. This loss of moisture in addition to the increase in the age of the eggs tends to decrease the vitality of the germ spots, and thereby causes unsatisfactory hatching result. Here, again, the per cent of hatch during the first period, December, January, and February, is higher than during the other periods. This is probably due to the

same cause as was given in the explanation for the differences in the per cent of "dead".

The weather conditions during these different periods may be another explanation for the differences in these hatches. During the first period the average temperature was only 24.4° C., whereas in the second and third periods the average temperature was 27.9° C and 26.4° C respectively. It has been observed that during the hottest months, March, April, and May, and some parts of June, July, and August, the setting hens would leave the nests very often, and it is also very probable that an excessive cooling of the eggs may have been another reason for the lower hatches obtained during these periods.

SUMMARY AND CONCLUSIONS

(1) It was observed that the per cent of infertility increased as the time of holding the eggs previous to incubation increased. This was also true with the per cent "dead".

(2) The best results were obtained from hatching fresh eggs. The per cent of hatchability decreased as the time of holding the eggs increased.

(3) Better hatching results were obtained during the months of December, January, and February, than during March, April, and May, and June, July, and August.

(4) Ten days may be considered a time limit for holding hatching eggs during December, January, and February, but during the hottest months of the year all eggs should be hatched while fresh.

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TABLE I.—*Hatching results with the Cantonese eggs*

Age of eggs.	December, January, February					March, April, May					June, July, August				
	No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert	Per cent dead.	Per cent hatched		No of eggs set	Per cent infert.	Per cent dead.	Per cent hatched.	
				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.
Fresh	44	11.3	15.3	75.0	92.3	93	12.9	18.5	71.0	81.5	24	4.2	21.7	75.0	78.3
5-day	43	30.2	16.6	58.1	83.3	73	17.2	37.6	51.6	62.3	24	4.2	43.4	54.1	56.5
10-day	43	34.9	17.8	53.5	82.1	93	30.1	80.0	14.0	20.0	24	8.4	54.5	41.6	45.5
15-day	40	62.5	53.3	17.5	46.6	93	35.5	93.3	4.3	6.7	24	25.0	100.0	0	0
Weather records	Av. temperature—24.4 C. Amount rainfall—111.4 mm. Av. velocity of wind—610.4 miles					Av. temperature—27.9 C. Amount rainfall—358.7 mm. Av velocity of wind—652.5 miles					Av. temperature—26.4 C. Amount rainfall—705.5 mm. Av. velocity of wind—546.5 miles.				

TABLE II.—*Hatching results with the Barred Plymouth Rock eggs*

Age of eggs.	December, January, February					March, April, May					June, July, August				
	No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.	
				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.
Fresh	36	16.7	13.3	72.2	86.7	42	16.7	22.8	64.3	77.1	9	22.2	14.2	66.7	85.7
5-day	36	27.7	19.2	58.3	80.7	42	19.0	47.0	42.9	52.9	9	22.2	57.1	33.3	42.8
10-day	36	38.8	31.8	41.7	68.2	42	42.9	79.1	11.9	20.8	9	22.2	71.4	22.2	28.5
15-day	35	51.4	58.8	20.0	41.2	42	45.2	82.6	9.5	17.4	9	11.1	100.0	0	0
Weather records	Av. temperature—24.4 C. Amount rainfall—111.4 mm. Av. velocity of wind—610.4 miles.					Av. temperature—27.9 C. Amount rainfall—358.7 mm. Av. velocity of wind—652.5 miles.					Av. temperature—26.4 C. Amount rainfall—705.5 mm. Av. velocity of wind—546.5 miles.				

TABLE III.—*Hatching results with both the Cantonese and the Barred Plymouth Rock eggs.*

Age of eggs.	December, January, February					March, April, May					June, July, August				
	No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.	
				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.
Fresh ..	80	14 0	14 3	73 6	89 5	135	14 8	20 6	67.7	79.3	33	13 2	17.9	60 4	71.1
5-day..	79	29 0	17 9	58 2	82 0	135	18 1	42 3	47 3	57 6	33	13.2	50 2	43.7	49.7
10-day..	79	36.9	24.8	47 6	75.2	135	36 5	79 5	13 0	20 4	33	15 3	62 9	31 9	37 0
15-day.	75	57 0	56 1	18 8	43 9	135	40 4	87 9	6 9	12 1	33	18 1	100 0	0	0
Weather records	Av. temperature—24.4°C. Amount rainfall—111.4 mm. Av. velocity of wind—610.4 miles.					Av. temperature—27.9 C Amount rainfall—358.7 mm Av. velocity of wind—652.5 miles.					Av. temperature—23.4 C. Amount rainfall—705.5 mm. Av. velocity of wind—546.5 miles.				

CURRENT ECONOMICS OF TROPICAL PRODUCTION: III

THE PHILIPPINE ISLANDS AS A MARKET FOR AMERICAN RICE

Since 1905 the production of rice in the United States has increased from 800 million pounds to over 2500 million pounds. During the same period exports from the United States have increased from 200 million to 2000 million pounds and imports have decreased from 300 million pounds to less than 50 million pounds. The net internal consumption has, therefore, fallen from 900 million to 550 million pounds in the face of open attempts to induce the American consumer to eat the Oriental cereal. The result is that the United States producer is looking for a wider export market, wanting which, he must reduce his acreage. Over a year ago he began to inquire as to the possibility of the Philippine Islands as an export market.

The possibility of the Philippine Islands as a market for the United States rice surplus rests upon an evaluation of numerous factors. The more obvious factors may be listed as: (1) Deficiency in domestic production; (2) Time and credit requirements; (3) Distributive mechanism; (4) Price maximum; and (5) Legislative conditions.

Deficiency in domestic production.—The Philippines have not produced a sufficient supply of their staple cereal since 1854. The possibility of their doing so is remote for the following reasons:

(a) There are numerous competing crops, crops that from time to time become "bonanza" projects and land area, capital, and labor usually devoted to rice is forced to make room for such crops. The war impetus for coconut oil resulted in the conversion of considerable rice acreage into coconut groves and a more considerable area of open grass lands theretofore uncultivated but distinctly suitable for the primary cereal were instead seized upon for coconut plantations. While it is quite simple to convert rice or open area into coconut groves it is quite another thing to later reconvert any part of the groves into rice land. However low the price of copra may fall and however high the price of rice may climb, maturing coconut trees are not at all likely to be uprooted.

High prices for abaca resulted in the abaca regions in a similar conversion of rice lands and while the plowing up of recent abaca plantings is more thinkable than the reconversion of coconut groves, it is still not to be counted upon. Abaca is not, however, quite the land competitor that coconut trees are, for abaca is usually planted on newly cleared hilly land.

A third competing crop is sugar, but rice land once planted to sugar may be changed back to rice with greater ease than in the case of either coconuts or abaca. It must be borne in mind that all three of these crops preceded rice in the chronology of war time price increases and were extended to a greater or less degree at the expense of the great food crop. Tobacco which also preceded rice in the matter of demand stimulation did not compete with it for land, due to definite regional rather than agronomical or economic detail.

(b) In addition to the three crops, coconut, abaca, and sugar having priority in war time stimulation, rice farming is closely bound with several un-

favorable economic and social conditions of production sufficient to offset the significant price differential which now maintains in favor of rice. More than our other crops, rice is the intimate and traditional production of the native inhabitant, the only important food crop under cultivation at the time of European conquest, 1565. And as such, rice is clothed with a pernicious tenancy system involving inheritable bonded debt, usury, and veritable peonage not evident in any relative strength in the economy of other crops. The new Filipino, if we may be enigmatic, finds little attracting to a continuance, much less an expansion, of the existing rice area and its conditions. Nor does the government provide him the means to overthrow or to compete with the existing system.

(c) A third disadvantage of rice culture in the Islands rests on the excessive costs of production. Especially is this true in the harvesting where a man with a week's work on another's field receives as much palay (unhulled rice) for his share as he himself could produce with five times the effort. Recent attempts to lower traditional share allotments for harvesters or to substitute for them almost twice the current daily wage have met with successful resistance. The rice harvester receives at present an average wage in commodity of about three and a half to four pesos a day as against a current daily cash wage of less than one peso. Accentuating this disadvantage is the fact that rice imported from Indo-China is cheaply produced in that labor-seething market and can undersell the cheapest production in the Islands. It is the writer's opinion that no Filipino on a pure basis of dollars and cents in normal times can afford to raise the cereal. There are few cases of financial success among its producers in the Islands. It is only the fear of a break-down in the distribution of imported rice due to poor communications, a thing which has in the past occurred, and the rider that he thereby furnishes against exorbitant prices of the imported article, that lead him to devote his effort and capital to so comparatively unprofitable a crop.

(d) In answer to the notes given above regarding non-expansion of crop area the local rice optimist is inclined to point to wide areas of uncultivated open grass lands in Mindanao and the hinterland of Luzon and exclaim that there is the solution, there the room for expansion of rice land. "Urban dwellers with slightly bucolic minds" see everything in these grass lands. Everything is truly there in potentiality, everything might be there, but the first thing that must be there is communication. The middle west of America was pioneered over those most excellent of watercourses, the Great Lakes, Ohio and Mississippi rivers, and not otherwise. The so-called "Great West" of America received its first material development subsequent to the first transcontinental railways.

(e) Add to this lack of communications the futile character of land alienation laws now governing in the Islands; the right of the Director of Lands to delimit homesteads; the unsuppressed title juggling that has gone on now for ten years; and the inexcusable lack of surveys and titles. Add to it all the ponderable social deterrent of the gregarious non-pioneering habits of the Filipinos who are now the world's most distinctive "townsmen", and doubt must logically exist as to unaided expansion of the rice area of material extent in the near future.

The Philippine Islands will consume annually quite 2½ billion pounds of rice The per capita yearly consumption is over 200 pounds and the population numbers well over 10 millions. Production in the most favorable years has

reached slightly above 90 per cent of the requirement. The current actual deficiency will fall between 150 and 200 pounds and this deficiency will be made up by imports. The primary and limiting factor, the actual deficiency, is distinctly favorable to importation of rice and will so continue for many years.

Time and credit requirements.—Whatever may be the year's total demand for rice, however acute the shortage in native production, a review of past data indicates that the bulk of imported rice in the Philippines moves during the months from May to October. This is due to the fact that the native crop is largely harvested in December and this stock is depleted before recourse is had to importation except in limited industrial centers where there appears a somewhat greater constancy of demand for the cheaper grades. If American ports contemplate shipment of rice prior to April 1924 to the Islands, the American brokers must be prepared to extend a minimum of six months credits and an average of eight months credits on the bulk of their transactions.

Distributive mechanism.—The distribution of imported rice in the Philippine Islands is effected by means of what we may call, for want of a better term, "guild"—a Chinese rice guild with its apex in French Indo-China (Saigon) and its base in the two to twenty Chinese vendors found in every municipality of the Islands. The middle courses of the pyramid are the Chinese bankers and Chinese brokers in Manila, their branch houses and allied provincial Chinese go-downs. Parenthetically, this same combine controls the milling and distributing of all native rice production that enters into commerce and all other staple foods of native importance. The guild is a complete vertical and horizontal trust, feudal, racial, close-knit, hard-set, ancient, and thorough. It controls warehouses and steamship lines. To the Filipino consumer it is everything that some Americans have feared the "Big-Four" packers of Chicago might become to Americans—with this difference, that because of the distribution of native wealth, the smallness of the same, and the fact that commercial Chinese recognize and are guided by the eventual futility of profiteering, price extortion has never, with few exceptions, been attempted. Moreover, the Chinese trader is a man without a country, politically inconsequential and if his inherent honesty and centuries of tradition did not, as they do, deter him he would yet find it a social and political impossibility to profiteer.

The all-Chinese rice combine must be thoroughly realized by prospective American exporters. It is an extremely sensitive organism, fits its prices to daily conditions, extends to the honest natives an impressive mass of store credit, collectible only in kind at harvest time. The system has an unimaginable facility for minutia and point economy, is completely conscious and reacts to every condition so speedily as to indicate an almost intuitive sensibility. The like and economy of this guild is not to be found in the world outside the Chinese markets in Malaysia.

Needless to say, American exporter can neither compete with nor overthrow the distributive system in the Philippines food market. There remains the question, "Can he invade or make use of it? Can he replace the Indo-China apex with an American apex?" He can *if he may undersell the producers in French Indo-China.* This possibility rests upon six arguments.

(a) American exporters have experienced little difficulty in invading the Chinese retail mechanism to introduce American tinned goods practically to the

exclusion of all other similar items, and to acquire a consequential share of the cotton goods business.

(b) The capital which controls the Philippine distributive combine is in the hands of Chinese merchants and bankers in Manila, not in Indo-China.

(c) The Indo-China producer is mainly European and has little if any racial claim on the Chinese distributors.

(d) The Chinaman buys in the lowest market without sentimental interest (except in the case of Japanese goods).

(e) The Chinaman likes the American with an almost pathetic enthusiasm. If sentiment ever sways the Celestial it will do so to the American's advantage.

(f) There exist a few American firms in the Islands that maintain a liaison between the American exporter and Chinese importer active especially for tinned goods and hardware but potential for expanded relations. These might attempt to break the ground for the prospective rice market. The distributive mechanism might, then, with difficulty be turned towards American rice.

Price maximum. The greatest price at which United States rice might sell in the Philippines is fixed on the basis of two ascertainable facts the determination of which lies outside the Philippines.

(a) The local retail price of rice in the Philippines (common grades, December, 1923) is between three and a half and four cents gold a pound. Let us suppose American exporters undersell at three cents gold a pound, there remains no assurance that Saigon rice would not be offered at two and a half gold. The base price of Philippine imported rice must be the cost of production in French Indo-China and not the trade price in Manila. We do not know and have no way of discovering at the base (consumption) the margin of profit at the apex (production).

(b) The transportation and laying down charges must be equalized. If low incidental or fill-in rates by United States Shipping Board vessels are possible, this can be accomplished. The possible price maximum is unknown at present and unfavorable to American rice exporters. They would have to lay the cereal down in Manila at a price which French Indo-China's production could not meet.

Legislative conditions.—The rice growers of the Philippines have long demanded a tariff on rice, which demand was heeded by the Legislature of 1922. Every cavan (126.5 pounds) of clean rice coming from foreign ports pays $1.50 duty. Rice coming from the United States is, of course, free of duty. The effect of the duty so far has been to peg the retail price of rice at about 4 cents gold a pound rather than to appreciably increase production.

Summary.—American rice producers are in need of an export market; the Philippine Islands has an annual deficiency of approximately 200 million pounds; a tariff favorable to the United States exists; but American participation in the Philippine rice market necessitates long term credits, an invasion of a long-established Chinese distributive organization, *and the production and laying down in Manila of rice at an over-all cost less than that of the French Indo-China producer who is endowed with cheap labor, is nearer the market, and has held it for seventy years.*

EVETT D. HESTER
Professor of Economics.

AUTOPSIES[1]

By A. K. Gomez

Of the College of Veterinary Science

The teaching of pathology will be of little practical value without autopsies. It is essential that the students taking the course be trained in systematic post-mortem technique and be instructed in the proper interpretation of the lesions produced by a disease as presented in the post-mortem table after death. This will help them materially in making a clinical diagnosis in their practice of medicine.

Very often a veterinarian, whether in private practice or in the field as a government live stock inspector, is called upon to perform the autopsy of an animal dead of an unknown disease. Without the proper training in post-mortem technique, he will naturally experience difficulty in reporting a reliable diagnosis. He will be unable to present a well written and comprehensive protocol on the subject autopsied and may, as a consequence, lose the first opportunity to check the incidence of an epizootic.

To supply this practical training, as supplementary to the course in pathology given in the College of Veterinary Science, systematic autopsies of dead animals obtained from neighboring places, the clinics of the College, and the Animal Husbandry Department of the College of Agriculture, are being conducted throughout the year by the Department of Pathology and Bacteriology of the College of Veterinary Science.

Most of the autopsies are performed by the students themselves under close supervision of the professor in charge. The students are arranged in groups of three or four depending upon the size of the class. One student takes notes and the rest of the group are assigned to the different regions of the body. During the autopsy the students are requested to describe and diagnose in a brief manner the pathological changes found in each organ dissected out. A summary of the lesions is made at the termination of the necropsy and the cause of death is then determined.

Further work consists in making histological sections of tissues and bacteriological examination of secretions, fluids, blood, etc., whenever necessary, in order to verify the findings. Specimens for a pathological museum are collected from time to time and preserved following the Kaiserling process. The students are required to submit a well written protocol within two days after the necropsy. This is corrected and placed on file.

From January 1 to December 31, 1922, there were a total of 104 autopsies performed in the College of Veterinary Science. They were as follows: — Horses, 3; cattle, 12; carabaos, 6; swine, 17; dogs, 15; goats, 4; sheep, 1; fowls, 24; guinea pig, 19; rats, 3. Aside from these there were many autopsies of experimental nature of rats and guinea pigs which, for convenience and due to limited time, were reported under Laboratory Examinations.

[1] Experiment contribution No. 214.

The following table shows the cause of death in the different animals on which autopsy was performed.

Diseases	Horses	Cattle	Carabaos	Dogs	Swine	Goats	Sheep	Guinea Pigs	Fowls	Rats	Total
Ascariasis (calf)		2							4		6
Acute gastro-enteritis (calf)		1									1
Acute sero-fibrinous peritonitis		1									1
Acute gastro-enteritis				1							1
Acute hemorrhagic gastritis						1					1
Arsenic poisoning									1		1
Acute hemorrhagic enteritis									2		2
Botulism									2		2
Congestion of the brain		1									1
Decomposition too advanced							1		1		2
Encephalitis		1									1
Filariasis (Dirofilaria immitis)				1							1
Fowl cholera									2		2
Fowl typhoid									2		2
Generalized epizootic lymphangitis	1										1
Gastro-enteritis (distemper)				1							1
Gastro-enteritis							2				2
Hemorrhagic septicæmia					3						3
Hemorrhagic gastro-enteritis					1						1
Hog cholera					3						3
Heat Stroke					1						1
Hemorrhagic cloacitis									1		1
Inanition						2	1	4	2		9
Intestinal impaction								2			2
Internal hemorrhage (ruptured auricle)									1		1
Kidney worm infestation					1						1
Pneumonia	1	3			6	1			1	2	14
Pyemia									1		1
Purulent peritonitis									1		1
Rinderpest		5	4								9
Sapremia					1						1
Septicæmia				1					2		3
Strychnine poisoning (experimental)				10							10
Scurvy								8			8
Sero-fibrinous peritonitis								1			1
Tæniasis									1		1
Toxemia								2			2
Traumatic injury										1	1
Uremia	1										1
											104

It may be noted from this table that pneumonia was the cause of death of a large variety and number of animals. The ten cases of strychnine poisoning in dogs were subjects used in an experiment. In September, rinderpest was introduced into the College herd, but, fortunately, due to its early discovery and the immediate institution of strict quarantine and sanitary measures, the epizootic was promptly checked. It will also be noted that many of the diseases here reported could have been cured with early and adequate treatment.

ABSTRACT

The nutritive value of the proteins of coconut meal, soy beans, rice bran and corn. H. H. MITCHELL and VALENTE VILLEGAS, *Department of Animal Husbandry, University of Illinois, Urbana, Illinois. Journal of Dairy Science* **6.** 1923.—The work was conducted to determine the value of the proteins of coconut meal, soy beans, and rice bran, and combinations of these with one another and with corn for maintenance and growth through metabolism studies with rats.

The losses of nitrogen on an N-free ration.—The losses of nitrogen in the urine during the first period of the experiment comprising seven days while the animals were receiving N-free ration was on the average 20.6 milligrams per 100 grams of body weight of the animal. The losses during the last period of the same duration when the rats were again put on an N-free ration was less than during the first period due probably to lessened vitality of the animals. The losses in the feces while the N-free ration was being given was also determined and is known as the "metabolic nitrogen" of the feces. The losses of this metabolic nitrogen during the first period was on the average 193 milligrams per 100 grams of food during the first period and 206 milligrams per 100 grams of food during the second period.

Results with low protein rations.—Rations containing 5 per cent of protein were tried. These included coconut meal, soy bean, and corn rations. The average utilization of the protein of coconut meal was 77 per cent, of corn 72 per cent, and of soy bean 78 per cent. Thus it may be concluded that there are no differences in nutritional value between the different classes of proteins found in corn, soy bean, and coconut meal when fed at a level of 5 per cent, but these differ in digestibility.

Results with medium protein rations.—Six rations were used in which the amount of protein in the feeds approximated 10 per cent. Besides the coconut meal, soy bean, and corn rations, combinations of these were used to determine any supplementary effect that the protein of one feed may have upon that of another. The average utilization coefficient found with the protein of coconut meal is 58, of soy bean 64, and of rice bran 67. According to these figures, it is evident that the proteins of coconut meal are less efficient for body requirements than the proteins of soy bean and rice bran, and that these two are almost equal in efficiency. In the combination rations the protein was derived from the constituent feeds in equal parts, the total amount being 10 per cent. The results of the experiment with these rations show that coconut meal and corn mixture has

a value of 58 per cent, showing no supplementary effect of any of the constituents of the feed. Soy bean and corn mixture gave a utilization coefficient of 66, thus indicating a slight supplementary effect of one feed upon another although the tests were too limited to warrant definite conclusion. Rice bran and coconut meal mixture gave an average value of 63 per cent or just the average of the value for coconut meal and rice bran. The results with the mixtures are in accordance with the other trials on vegetable proteins in which generally no marked supplementary effect of one protein upon another is shown. Supplementary effects have, however, been found when animal proteins are mixed with vegetable proteins.

The net protein values of feeds.—The average net protein content of some feeds have been determined as follows:

Feed.	*Content of net protein. per cent*
Corn	4.3
Rice bran	5.3
Soy beans	19.6
Coconut meal	11.1
Cottonseed meal	24.4
Alfalfa hay	6.6

Abstract by Valente Villegas.

COLLEGE AND ALUMNI NOTES

The Board of Regents and the Executive Committee of the University of the Philippines met at the College of Agriculture on October 27. An inspection of the College and the Experiment Station formed a part of the meeting.

Dean Maximo Kalaw of the College of Liberal Arts and member of the Executive Committee remained for a day or so as the guest of his sister, Mrs. Manuel Roxas, and went snipe hunting with Doctor Roxas and Moises Kalaw, who is a student in the College.

The Los Baños Biological Club, composed of members of the faculty of the Colleges of Agriculture and Veterinary Science and the School of Forestry interested in biological research, was organized November 15, 1923. Doctor B. M. Gonzalez, '13, of the Department of Animal Husbandry, is President of the Club, and Doctor L. B. Uichanco, '15, of the Department of Entomology, is secretary. Scientific programs will be arranged monthly, and brief papers will be read and discussed. The first meeting of the club, Los Baños Biological Club, was held on December 4, 1923, in the College of Agriculture Auditorium, when papers were read by Professor Dacanay, Doctor Tubangui, Doctor Fronda and Professor Herbert.

At the last meeting of the Ranchers' Club, the following members were elected to manage the affairs of the club this semester: Governor, Alejandro Catambay; Lieut. Governor, Eulogio Rodriguez, Jr.; Secretary, Mamerto E. Limuaco; Treasurer, Filomeno S. Mariano; Sheriff, Louis J. Dangilan; and Adviser, Doctor F. M. Fronda. The first anniversary of the club was celebrated with a live stock parade November 17, which was pronounced a decided success. A program, consisting of addresses by Dean Baker, Doctor Gonzalez, Doctor Fronda, and Profesor Elayda, Director of Extension Work, and musical selections by the College orchestra, formed the second feature of the celebration. The Ranchers' Club is a club of students who are majoring in Animal Husbandry.

Doctor José J. Mirasol, '15, Dean, Junior College, University of the Philippines at Cebu, was at the College recently for a short visit.

Professor Elayda, Director of Extension Service, went recently with Severo Capistrano, '15, to Paete, Laguna, for lanzon investigation.

Pablo N. Mabbun, B. S. A., '23, Assistant in Economics, was married to Miss Consolación B. Zarcilla of Rosales, Pangasinan, on November 18. The wedding was solemnized at Pasay, Manila. Mr. and Mrs. Mabbun have taken up residence in Anos, Los Baños.

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LEANING ON THE GOVERNMENT

Depending upon the Government to do a lot of things for you which you could do as well or better for yourself involves a shirking of responsibility; it implies a naive reliance upon some sort of supernatural power with which the popular imagination seems to clothe the Government.

Government is not a natural agent—it derives no power, no vision, no ability from any source other than the resources of the people themselves. A government can be no greater industrially, or purer morally, or more competent mentally than its makers. Governments are not ordained; that idea of government disappeared when men discarded the notion that their rulers were such by divine right. Governments are constituted, erected as a scheme of organization intended and designed to protect the public welfare.

Once we lose sight of the fundamental concept of representative Government—that is, that it is a system under which the individual must always be accorded the fullest possible freedom of action, a system under which self-reliance and independence are conceived to be the supreme virtues of manhood—we cannot avoid being led deeper and deeper into the morass that surrounds the public welfare, ideas that belong to concepts of government which vision the individual as a weakling and the government as a crutch for him to lean on.

—*Selected.*

SOME ECONOMIC AND SOCIAL ASPECTS OF PHILIPPINE RICE TENANCIES[1]

By EVETT D. HESTER, PABLO MABBUN, ET AL

WITH STATISTICAL APPENDIX AND SIX TEXT FIGURES

INTRODUCTION

HISTORICAL REVIEW OF PHILIPPINE TENANCY

The actual and documented history of Philippine agriculture has not yet been attempted, but it will be of interest to quote a few secondary sources to indicate the chief phases in the history of Philippine land tenure.

The pre-Spanish barangay.[2]—In general the tenant problem of the Philippines is new, while tenancy itself is contemporaneous with the Malay occupation of the Islands. The original tenure system of the present inhabitants is indicated by Fernandez (1). "The civilized Malay travelled (to the Islands) in a large and swift kind of native boat, called *barangay*. In each boat was a dato, or chief, with his followers." Jernegan (2) writes, "In later days (after Spanish conquest) these headmen were called *cabezas de*[3] *barangay*—the people that came in the same boat settled in one village with their captain as headman."

T. H. Pardo de Tavera (3) asserts, "When the Spaniards arrived in the Philippine Islands they found the inhabitants of Malay blood divided into groups, each having its own government. These small groups were in many places known by the name of *barangay*, which is also the exact word used to describe a small craft used by the indigenes and would therefore appear to indicate that the people forming each of these town groups were descendants of the crews of particular crafts since the time of their original immigration to these Islands. The population of the various *barangayes* was in some cases not over 50 inhabitants, and in others, as was observed by Salcedo in Ilocos, the number reached as high as 7,000."

In the establishment of the *barangay* under their pilots or headmen there was laid the basis of an early formed, natural, and feudal system of land tenure, one which might have endured and evolved had its foundations not been overturned by foreign conquest. Even today there may be traced vestiges of this historic and normal tenure. According to Miller (4), "The manner in which the Philippine Islands were originally occupied is illustrated by the procedure

[1] Experiment Station contribution No. 210, combining unpublished theses presented for graduation from the College of Agriculture, Nos. 168, 169, 170, 171, 172, and 173, and unpublished Papers in Rural Economics 99 Nos. 2 and 3.

[2] A Malaysian term meaning originally a boat, but as applied in the Philippine Islands, a hamlet, thus implying the mode of settlement.

[3] Spanish, literally "heads of"

of Ilocano immigrants in settling new country. They come in groups of from five to twenty, each group under a headman who takes possession of a certain amount of public land. When this land is cleared and put in a state suitable for cultivation, it is divided among the immigrants by the headman. The land is distributed among those constituting the community, but the title remains in the name of the headman."

The Spanish encomienda.[4]—In the early Spanish days of the Islands there appear two elements which affected land tenure in opposing ways.

The first element was the diminution and final absorption of the *barangay* tenure into the *encomienda* system. According to Fernandez (1), "The datos kept their position of leadership but their power was greatly diminished. In the course of time they became known as the *cabezas de barangay,* or headmen, and were usually intrusted with the collection of tributes (for the Spanish). From time to time the Spanish governor gave large grants of the land to Spanish citizens of the Islands. The Filipinos living in the villages and towns on the grants went with the land. The groups of Filipinos on a single grant usually varied from three hundred to one thousand. The grant of land and people was called the *encomienda* or *repartimiento.*[4]—The holders of the *encomiendas* were called *encomenderos* They were supposed to take care of the inhabitants in their *encomiendas* and rule over them. Every male in the *encomienda* between the ages of sixteen and sixty was obliged to pay to the *encomendero* an annual tribute of eight *reals* in silver or the equivalent in products of the locality."

It will be seen at once that, as in all original systems of tenure, the primary element was government and protection. In fact both the early Malay *barangay* and the Spanish *encomienda* are to be primarily studied from their governmental standpoint. It is equally apparent that the Spanish system laid the basis for that least picturesque type of European feudalism so successfully founded in Mexico. During the early occupation of the Philippines by Spain, the Islands were treated as an offshoot of Mexico and were ruled therefrom religiously and secularly. We have now to discover why the manorial system of the early Spaniards did not proceed beyond its governmental prerogatives, did not completely effect Mexican peonage in the Islands, and why it eventually disappeared as even a governmental element.

According to Jernegan (2), "The first insurrections against Spanish rule were caused by the hardships of the tribute which the *encomenderos* forced from the natives. In 1589 there were revolts in the Cagayan Valley and in Ilocos Norte, in which tax-collectors were killed."

Again quoting Fernandez (1), "The system was early seen to be the cause of many evils and the cause of general discontent. The friars started a movement to change the conditions caused by the *encomiendas* and especially by the greed of the *encomenderos.* Father Roda, the Provincial of the Augustinians, and later Domingo de Salazar, Bishop of Manila, denounced the cruel practices. The result was that in 1574 Philip II forbade his officials to hold *encomiendas.....* Governor de Sande tried to carry out the King's wish, but was unsuccessful, and the rule of the *encomenderos* was destined to continue for another half century." It is a matter of note that friar control was opposed to the extension of the *en-*

[4] Spanish term applied to a politico-agrarian form of tenure instituted largely in Mexico and the Philippines.

comienda system and for a time menaced and eventually made impossible the establishment through this system of a firm manorial tenure.

The lack of any large and influential class of Spanish agricultural capitalists or land grandees in the early part, and the lack of a considerable rural mestizo element in the latter part of Spanish occupation, aided to hamper the establishment of the Mexican type of peonage. Writing concerning these times, Pardo de Tavera (3) records, "Outside of the *encomenderos*, *alcaldes*[5], *corregidores*,[5] and enlisted men and officers of the army, few Spaniards were known to settle in the provinces and devote themselves to agriculture or any other industry."

The rise of Spanish friar estates.—The second element of importance in a historic review of Spanish land tenure in the Philippines was the building up of large friar estates. The friars were instrumental in overthrowing the *encomienda* system before it advanced far beyond its inception as a tax-collecting mechanism. Following this overthrow the Church Orders succeeded in discouraging any secular control of agricultural development. The friars constituted, in the provinces at least, the principal interpreters of Spanish government. At times they even discouraged travel into the outlying districts, and the government orders went so far as to prohibit foreigners from travelling in the provinces. Pardo de Tavera (3) writes, "Foreigners were absolutely prohibited from living in the Philippine Islands. Several royal *cedulas* were issued directing the governors not to allow foreigners who resided in the Islands to engage in commerce, nor under any pretext whatever to settle in the provinces or towns, in any locality in the Philippine Islands." No policy could have tended more to throw the balance of Spanish sovereignty into the hands of the friars and enable them to effect a complete shift in the system of tenancy from the secular *encomienda* to the friar estate.

As the *encomienda* passed out of existence the friar estate took its place. Whereas the former was primarily political in nature and had not the opportunity to institute a full-fledged system of tenure, the latter was apparently from the beginning a tenure system. The friar estate had, however, a strong apology in the fact that it was certainly less predatory than the *encomienda* might have become had it followed its parent model in Mexico. Concerning the growth of religious estates, Pardo de Tavera (3) writes, "The power of the friars in Manila soon became very great. At the start they were poor, but certain devotees made them donations, others left them inheritances consisting of lands and slaves, and in a short time the friars had become wealthy proprietors and independent of their own holdings for their sustenance, which was furnished by alms and gifts made to them by the King and by the followers of their Church Their territorial possessions increased rapidly; so much so that in 1601 the King commissioned the Auditor Sierra to compile data and send him a report as to the kind of titles and areas and description of the valuable lands held by the friars; but the friars refused to furnish any information to the auditor, stating that they were exempt from any such formalities, and as subsequently they were unable to prove the legality of their titles they were declared to be 'occupants in bad faith' and an embargo was laid on the lands held by them. When Archbishop Camacho arrived in the Islands the friars appealed to him for protection and this prelate ordered the auditor to stop his proceedings or he would excommuni-

[5] Titles of Spanish civil subordinate officials.

cate him. Taking advantage of this crisis, as they also did on other occasions, the friars threatened to abandon the Islands, and the Governor, in order to avoid a conflict, which had taken on alarming proportions, got the new *visitador*[6] who had succeeded Sierra to accept the titles to the lands held by the friars as valid; and when this was done the matter was pigeonholed."

Purchase and re-parcelling of friar estates.—The friar estates assumed immense proportions until at the inauguration of American Civil Government they amounted to 172,000 hectares of land. A considerable number of tenants had refused to pay rents during the revolutionary years from 1896 to 1902. In 1907 Secretary Taft consummated the purchase on the part of the government of the greater part of these lands for a sum of 14,474,000 pesos funded in bonds authorized by the government of the United States. The area purchased was 155,198 hectares which was to be sold to the tenants on easy terms. The Director of the Bureau of Lands (5) reported at the close of the fiscal year 1919 as follows: "Area sold to date, 109.253 hectares; area vacant, 45,746 hectares; value of land sold, 16,307,011 pesos; value of land vacant 3,807,329 pesos; and collections to date, 11,867,869 pesos." These figures constitute a very creditable financial showing. How little the purchase has effected a solution of the tenant problem is shown for two of the friar estates on page 383 in this paper. It is significant that Governor General Wood has pronounced his opposition to the further purchase and re-parcelling of large estates.

General existing tenure systems.—The only comprehensive and contemporaneous description in English of tenure systems existing in the Philippine Islands is that of Miller (4). A brief outline from his work is here given. Definition and discussion of the systems would be too lengthy for incorporation in this paper and the reader is referred to the source.

A) The proprietary tenure systems.
   1) The sugar *haciendas*[7] of Occidental Negros.
   2) The *haciendas* of Oriental Negros.
   3) The *haciendas* of Iloilo.
   4) The *haciendas* of Leyte.
   5) The *haciendas* of the Bicol Peninsula.
   6) The mixed proprietary share system of Cagayan Valley.
   7) The abaca plantations of Davao.
   8) The sugar *haciendas* of Laguna.

B) The peasant proprietary systems.
   1) The full resident peasant.
   2) The rented small plot owners.

C) The rent system.

D) The share systems.
   1) The manorial system.
   2) The *kasama*[8] share system.
   3) The scattered holdings share system.
   4) The interleasing share system.

[6] Spanish crown official who was in capacity an auditor.
[7] Spanish term applied to a large agricultural holding.
[8] Tagalog term applied to a share tenant, or cropper; literally, a companion.

GROWTH OF PHILIPPINE TENANCY

There were, according to the Census Office of the Philippine Islands (6), in this country in 1918 nearly two million agricultural holdings of which over 22 per cent were operated under some form of tenancy. In 1903, the United States Bureau of Census (7) reported for the Philippine Islands a proportion of tenancy of slightly over 19 per cent. During the past fifteen years there has been an increase of about three per cent in the proportion of tenancy. Although the census failed to group the tenure classes under crop classes, it is patent to any observer of rural conditions in the Archipelago that tenancy is much more prevalent in the cultivation of rice than in the cultivation of other crops. It may be safely estimated that 70 per cent of all Philippine tenancy units are devoted to the production of rice.

An increase of three per cent during an interval of fifteen years may not seem alarming. Its importance arises from the fact that natural conditions and resources argued for a heavy decrease in tenancy during that period. It has been a very general belief, as recently stated by Spillman and Goldenweiser (8), that tenancy decreases when desirable public land can be acquired at a minimum price and with minimum effort. Bureau of Commerce and Industry (9) estimates the land area of the Philippines under cultivation at six per cent and the area cultivatable at about 50 per cent. In addition there are very liberal homestead laws and very strict laws against large capitalistic holdings.

The anomalous condition of increasing tenancy in a country largely uncultivated, with wide areas of public domain and with very liberal homestead laws, is further emphasized in the small average area of the holdings. The Census Office of the Philippines (6) gives the average holding, freeholds and large estates included, as 2.3 hectares, of which 1.2 hectares are cultivated. The reluctance of the Filipino tenant to avail himself of the homestead law lies partly in his own gregarious nature which, according to Hester and Miñano (10), "induces his preference for insufficient holdings and a highly social village system to wider farms and probable isolation." It is further the result of a purely objective condition which lies in the marked slowness with which titles to new lands, as well to old claims, are acquired. As expressed by Wood and Forbes (11):

> The land titles situation in the Philippine Islands is a serious one. It should be the policy of the Government to push forward the cadastral survey, determine titles to lands as quickly as possible, and to facilitate in every possible manner the acquisition of title by homesteaders. Nothing is more conducive to good government than having the people secure in the ownership of their land and possessing titles guaranteed by the Government, as is practiced in the Torrens system. Filipinos have the excellent trait of a strong inherent desire to own their own land.
>
> The present unfortunate land title situation is largely due to an inefficient administration of the land office in recent years and to an increase in the number of problems which the Government has to handle.
>
> In 1913 the Insular Government had a thoroughly efficient and trained Bureau of Lands and an experienced and effective Court of Land Registration. Today any inefficiency of the Bureau of Lands is due, in part, to lack of experienced and trained personnel, to inefficient management and lack of funds.
>
> Delay in the obtaining of titles is also due to the abolition of the Court of Land Registration and to the transfer of land cases to the overloaded Courts of First Instance. This has resulted in an increase in the number of abuses by which the poor farmer and homesteader, ignorant of his rights, is forced off his land by his richer and more unscrupulous neighbor. The situation tends to serious discontent and must be corrected.
>
> An adequate Court of Land Registration should be re-established.

Again, in 1922, Governor-General Wood (12) writes:

> Surveys are backward and the people are clamoring for titles to their land. Tens of thousands of cases are awaiting adjustment. The land office needs a thorough reorganization, and in order to expedite its work, already years behind, there must be thorough co-ordination between the departments of natural resources and justice. Among the steps to be taken is the appointment of more judges or the re-establishment of the Court of Land Registration.

Further accentuating the severity of the situation the following extracts from the press are offered:

> In order to end the "eternal wrangle" between landlords, homesteaders, and lessees occasioned by delays in adjudication of titles to public lands of the Philippines, and which have caused the shedding of blood in many instances, Secretary Rafael Corpus of the Department of Agriculture and Natural Resources has recommended to the Governor General withdrawal from settlement of all the public domain in the Islands until the Bureau of Lands has completed all necessary surveys and the agricultural lands have been delimited from forest lands.[9]
>
> Perhaps Secretary Corpus faces a situation in which he is not able to make any other recommendation, but there can be no question that the public as a whole would be greatly benefited were it possible to work out a system whereby our land title machinery could be put into shape, added to and speeded up to a point where it would not be necesary to delay the filing of homestead applications even temporarily.[10]
>
> Any person who has given study to the agricultural situation in the Philippines realizes that one of the handicaps under which the country is working is found in the fact that a very considerable portion of the improved farming land in the Islands is controlled by large estates and that comparatively few individual tillers of the soil own holdings sufficient in size to be termed profitable farms.
>
> This landlord and tenant system has been a source of recurring discussion with each agricultural congress, and at least once a year forms the subject of debate upon the floor of one or both houses of the legislature. Strange to say, however, there seems to be but one proposed solution to the problem. There is a feeling that the government should step in and either compel the landlord to dispose of his holdings for the purpose of splitting them up among the tenants, or that laws should be enacted giving the tenant farmer a more advantageous position than that enjoyed by other renters.
>
> It appears to us that the most logical solution of the problem is not found in either of these propositions * * *
>
> This country is not land poor. It has public domain a plenty, and immense opportunities for the homesteader. Make homesteading safe, by proper assurance of titles, and easy, by expediting our registration system, and you will find a solution of the tenant problem that no prohibitive or restrictive legislation can ever furnish.[11]

AGRARIAN UNREST

As further indicating the rising agrarian problems of the Islands, Hester and Miñano (10) give several instances from the daily press of tenants petitioning the Governor General of the Islands for relief.

> Recently, there have been many published accounts of tenant protests in the Philippines. In July, 1920, the demands of tenants resulted in the division of the former friar estate of Cauayan. It was doubted that the division would aid in the decrease of tenancy to any considerable extent, as it was expected that rich proprietors from Pampanga, Pangasinan, Ilocos Sur, and Ilocos Norte, besides those from Isabela Province, itself, where the *hacienda* is located, had made known their intention to purchase portions of the land.[12]

[9] *Manila Daily Bulletin*, September 14, 1922
[10] *Manila Daily Bulletin*, September 14, 1922
[11] *Manila Daily Bulletin*, August 29, 1922.
[12] *Manila Daily Bulletin*, July 9, 1920

During the latter half of 1920, 500 tenants of San Juan del Monte marched to the palace of the Governor General to protest against increased rents of from six to forty-seven pesos per square meter per annum.[13] A settlement of this case was finally made through the good offices of the Governor General.

In the same month, the Governor General received a petition from 5,000 tenants of the Nagtahan estate in the districts of Sampaloc and Santa Mesa complaining against alleged increases in rents of from 500 to 1,200 per cent.[14]

In October, 1920, 5,000 tenants from the estates occupied by the Solocan Development Company marched to the Governor General's palace to place in his hands a petition requesting the Government to purchase the land concerned and sell it back to the tenants.[15]

The Payatas estate in Rizal province was re-parcelled and taken up by the tenants themselves during the month of October, 1920.[16]

Pronto (13) sums up certain other cases:

In August 1922 the San Pedro Tunasan tenants demanded that they be given the land which they worked,[17] demanding the annulment of the 'peonage' law.[18] Alarming reports were spread that class hatred was being fomented, the poor were making ready to start a fight against the rich; cases of incendiarism, sabotage, and depredation were said to be rampant.[19] It was said, also, that politics played an important rôle in the agrarian troubles in Bulacan. Thirty-one tenant delegates from Hacienda Buenavista presented their grievances before the board of directors of the San Juan de Dios Corporation, owners of the *hacienda*.[20] Tenants from La Esperanza Hacienda in Cuyapo, Nueva Ecija, paraded to demonstrate publicly their grievances.[21] In May 1923, about a thousand tenants in General Trias, Cavite, declared a general strike when the proprietors failed to grant the requests of the tenants. The same case happened in Imus, Cavite, at that time.[22] In July, 1923 the tenants and farm laborers of Tuy and Balayan, Batangas, sent a petition to the *Co-operative Association of Agriculturists* in the western region of Batangas which was later sent to the Director of the Bureau of Labor by the president of the *National Confederation of Tenants and Farm Laborers of the Philippines*. The latter in his capacity * * * sent a communication to the Governor General exposing the existence of peonage practices and involuntary servitude in that region.[23]

Thus, to quote again Hester and Miñano (10),

The Philippines experience the gravity of tenancy problems not only in the mere increase in number of tenants in the face of a large and fertile public domain, but also in the politico-social aspect of a heightening class consciousness among the *aparceros*[24] and *arrendatarios*[25] in whom there lies at this hour potentiality for the formation of either a strong middle class of freeholders, or a strong troublesome class of peons, less numerous but more effective, than the peons of Mexico. Wise legislation and meticulously just agrarian administration, alone, can adduce the former rather than the latter.

THE PROBLEM

The most vital problem facing the Philippines today is agrarian and social. It has to do with the establishment of a dependable rural middle class. The problem may be approached from two angles: (a) Avoid the growth of peonage in resolving tenancy into peasantry; and (b) Elevate a hand-to-mouth peasantry

[13] *Manila Daily Bulletin*, September 28, 1920.
[14] *Manila Daily Bulletin*, September 7, 1920, and *Philippines Free Press*, September 11, 1920
[15] *Manila Daily Bulletin*, October 11, 1920.
[16] *Manila Daily Bulletin*, October 11, 1920.
[17] *Philippines Herald*, October 4, 1923.
[18] *Manila Daily Bulletin*, August 28, 1922.
[19] *Philippines Herald*, April 17, 1923.
[20] *Manila Daily Bulletin*, September 13, 1923
[21] *Manila Daily Bulletin*, October 26, 1923.
[22] *Philippines Herald*, May 30, 1923.
[23] *Manila Daily Bulletin*, September 13, 1923.
[24] A Spanish term for share tenants.
[25] A Spanish term for tenants paying a specified rent, either of money or labor.

into a body of responsible freeholders of securely titled, suitably sized farms. The basic requisite for the solution is at hand in the unclaimed public domain consisting of 88 per cent of the gross area of the country. Legislative elements for the solution exist in the homestead laws and the provisions for Torrens titles. It remains to speed up the administration of the land policy and to educate the countryman away from the deterrent gregariousness of centuries.

Solutions of social problems are only by chance unless founded upon a basis of knowledge. If movements calculated to improve the condition of either tenants or peasants are to be undertaken without serious error it is imperative to know exactly who and what that tenant or peasant may be. As an illustration: observers of Philippine small farmers early discovered a lack of credit facilities available for their use. Promptly an Agricultural Bank was established. After a few years it was discontinued. Again, a series of Co-operative Rural Credit Associations were established. Their capitalization has been largely afforded by government doles and no published audit has been forthcoming. Their success is a matter of serious question. Here were instrumentalities well organized and well administered but with little success. The fault lay in a lack of knowledge or of cognizance of the elemental fact that there existed neither the thrift which furnishes deposits nor the security which enables loans. And now the Legislature proposes a third credit machine in the nature of subsidized country banks which will be required to loan to small farmers on clean security, small sums of money. A scant collection of data will indicate how utterly impossible it would be for such banks to obey their mandate.

It is, therefore, expedient that investigation precede action in the institution of economic and social reforms. The tenant and peasant must be known, his condition bared to the gaze of the legislator, educator, and administrator, before they may act intelligently in his behalf.

REVIEW OF PAST LITERATURE

There exists very little contemporaneous literature on the subject of Philippine tenancy. Miller (4) gathered economic reports in 1912 under the auspices of the Bureau of Education through one hundred and twenty selected supervising and high school teachers. In addition to a cautious discussion and careful comparisons of tenure systems, Miller presents an excellent chart showing for each agricultural district of the Islands the prevalent system of tenure. This work deserves the careful study of every student of Philippine land conditions, especially Chapter XIII on Agricultural Labor. Founded on exhaustive reports made by picked observers, most of them resident for several years in their districts, men in close touch through the common schools with every phase of provincial life, the facts set forth reflect accurately the status of land tenure in the Islands at the time.

The United States Bureau of Census (7) and the Census Office of the Philippine Islands (6) give for 1903 and 1918, respectively, the numerical coefficients of Philippine tenure. They could not within the scope chosen for their schedules indicate the social conditions or the more latent economic factors of the case.

In Hill and Moe (14) there appear excellent brief sections on tenure and contracts mostly applying to the northern part of Central Luzon, particularly the province of Nueva Ecija. Certain of their conclusions are discussed in this paper.

Under the various topics of discussion in this paper reference is made to a number of authorities on general and foreign tenancy.

OBJECT OF PRESENT WORK

In 1920, the Department of Rural Economics of the College of Agriculture undertook the levy of specific economic and social surveys upon small areas of considerable agricultural production, using a developed case system. The first of these surveys, reported in Hester and Miñano (10), was almost entirely economic in detail and had to do with tenancy on coconut land in the province of Romblon. This survey was more or less experimental and was largely useful in designating the system to be used. During 1921 and 1922 eight surveys were levied in districts in which rice was largely produced under share tenancy. These eight surveys were as follows:

A) *Tigbauan, Iloilo*
1) 50 tenancies surveyed.
2) Period of survey: December 1920 and January 1921.
3) Tabulations only.
4) Reported in Teruel (15).

B) *San Miguel, Bulacan*
1) 40 tenancies surveyed.
2) Period of survey: December 1920 and January 1921.
3) Tabulations only.
4) Reported in Santamaria (16).

C) *Santa Rosa, Laguna*
1) 81 tenancies surveyed.
2) Period of survey: March to June 1921.
3) Tabulations and narrative account.
4) Reported in Laserna (17).

D) *Hagonoy, Bulacan*
1) 138 tenancies surveyed.
2) Period of survey: April to June 1921.
3) Tabulations and narrative account.
4) Reported in Santos (18).

E) *Calasiao, Pangasinan*
1) 99 tenancies surveyed.
2) Period of survey: April to June 1921.
3) Tabulations and narrative account.
4) Reported in Royeca (19).

F) *Naic, Cavite*
1) 151 tenancies surveyed.
2) Period of survey: December 1921 and January 1922.
3) Tabulations and narrative account.
4) Reported in Rodis (20).

G) *Aparri, Cagayan*
1) 111 tenancies surveyed.
2) Period of survey: April to June 1922.
3) Tabulations and narrative account.
4) Reported in Mabbun (21).

H) *Bay, Laguna*
1) 160 tenancies surveyed.
2) Period of survey: June to December 1922.
3) Tabulations and narrative account.
4) Reported in Teruel (22).

The purpose of this paper is to present in combination the results of the eight surveys; to summarize the discussion which the data excite; and to draw limited conclusions relative to the best means of improving the lot of our great

body of rice tenants. In the educational economy of the College, the surveys have already played a desirable end. The investigators, senior students majoring in rural economics and, indirectly, the classes have been placed in contact with first hand information on the *modus operandi* of Philippine rice production and the *modus viviendi* of a considerable body of Philippine rice producers. If any college of agriculture is to fulfill its mission it must eventually reach, principally through the matrix of graduates, the fundamental producing element of the community. It is particularly necessary in the Philippines where there is a marked tendency to attempt the disastrous and illogical separation of "practice" and "science," that the few educated farmers appreciate to the fullest the real condition of the average *tao* (peasant) farmer and tenant.

METHOD OF SURVEY

The areas selected for investigation were chosen principally on the basis of residence of the investigators. The Department of Rural Economics selected majoring seniors who showed ability and interest in survey work and who lived in distinctly rice producing districts and assigned to them their native barrios as a field. The senior author visited each area surveyed, except Hagonoy and Calasiao, either during or subsequent to investigation.

In obtaining the data of the surveys the investigators made a house to house canvass of the tenants. Each investigator, except Teruel at Bay, was a citizen of the municipality in which his investigation was carried out and related by blood to the tenant class of the locality. In the investigation at Bay the investigator was accompanied by an assistant who was familiar with the tenants of the locality. The reticence with which government officials, enumerators, and foreign investigators are commonly confronted was thus obviated. Whenever the tenant appeared to have overstated the facts, a parallel questionaire was worked out with the landlord, and if serious discrepancy was proved, the unit was thrown out. The same plan was followed whenever the tenant showed inability through ignorance to give reasonably accurate replies to questions.

Figures on areas were frequently checked by comparing the tenant's estimate with the quantity of seed rice required to sow his area. In a few cases the landlord's books were available to show the areas held by each tenant. It was, however, surprising to find many landlords who had no accurate idea of the areas held by their tenants. The surveys, as they were finally composed, covered only those units for which the data sheets presented no anomalies indicative of exaggeration or misinformation.

DISCUSSION

The data of the various surveys on which discussion is based will be found in brief form in the Statistical Abstract appended to this article. Reference thereto is indicated throughout the paper. The narrative accounts submitted by the investigators in six of the surveys (Santa Rosa, Hagonoy, Calasiao, Naic, Aparri, and Bay) are of equal if not greater importance than the tabulations. Much of the discussion is influenced by a reflection of facts from these narrative accounts.

No division between economic and social discussion has been made. In many cases the line betwen the two is difficult to draw. There are numerous inter-relations especially in discussion which bring both bodies of fact into contact.

AREA

[Statistical Appendix, Section I]

Nourse (23) designates area as the "fundamental fact" in agriculture. Although area must be conditioned upon precedents of a geographic, social, and even racial character, there are several reasons why it may be taken as the central point in rural economy. First, the great difficulty of appraisement of the precedent causes of area offers an impasse to the student. Again, area is subject to a minimum of fluctuation both quantitatively and on the point of time, providing, especially in regions of an ancient and consistent ethnos, a reliable constancy. Area itself submits to an easy and accurate description. Finally, nearly all other factors which enter into rural economy operate within the set limits of area and are more frequently than not traceable to it as principal cause. As will be discovered, area is taken in this paper as the *point d' appui* of nearly all other considerations. Practically, area has been considered under several headings; gross area, cultivated area, and effective area.

Gross area.--Gross area is taken to mean the superfice of the holding regardless of its culture or cropping system. All surveys taken together presented a gross area of 1975.2 hectares. The averages for each tenant in the different surveys showed a variation of from one hectare, the average for Calasiao, to 4.7 hectares, the average for Santa Rosa The average for all tenancies of all surveys was 2.4 hectares which compares closely with 2.8 hectares the average of all Philippine share tenancies as given in Census Office (6). The Census does not contain figures for rice tenancies alone.

Regarding the range from minimum to maximum of individual holdings rather than the averages, the variation was found to be most narrow in San Miguel with a range of from 2.0 to 2.5 hectares and widest in Tigbauan and Hagonoy with a range of from 0.3 to 10.0 hectares.

Cultivated area.—Cultivated area is that portion of the superfice under the plow during the farm year However important gross area may be, productive efficiency will be more closely limited by the tilled area. The total tilled area of all surveys was 1968.6 hectares or 99.7 per cent of the total gross area. The cultivated and gross areas were identical in all surveys except Calasiao and Naic where the proportions were 97.5 per cent and 98.5 per cent respectively. Census Office (6) gives 52.9 per cent as the proportion of cultivated to gross area for all Philippine farms. The wide discrepancy between the Census and the surveys is due to the fact that the investigations were consciously laid in districts of complete cultivation. The uncultivated 47.1 per cent Philippine farms is not ordinarily found in the small tenant holdings but in the large estates operated on a proprietary basis. The waste land is also largely on the perimeter of the agricultural districts, whereas the surveys were levied in provinces and municipalities having a density of population of more than 250 to the square mile. Finally, the uncultivated farm land is seldom located in the rice producing areas but is largely found adjacent to tobacco, hemp, coconut, and sugar areas.

Effective area.—Wherever a second crop is planted on the cultivated area after the harvest of the first crop, but within the same year, it is necessary to distinguish an effective area which is greater by the portion of replanted superfice than the cultivated area. Effective area must not, however, be confused with the so called "two-crop system" and "three-crop system" which, in rural eco-

nomics have come to designate systems of combined diversification and rotation involving two or three crops within two or three years.

The effective area for all the surveys was 106 per cent of the gross area due to a limited crop of maize planted in some rice paddies in Calasiao immediately after the rice harvest and a second rice crop in Santa Rosa. Two crops a year are neither customary nor rare in the Philippines. They occur especially under irrigation, as at Santa Rosa where a system built by Friars over a century ago affords water for a second crop for each half of the municipality once in two years. However, the water for the second crop is seldom, if ever, sufficient to enable the favored half to replant the entire area. Naic, also, is favored by an irrigation system of prime importance to the successful production of the first crop and totally inadequate for a second crop.

Causes for small holdings.—The precedents of area re very difficult but a few of the more obvious may be mentioned. Rice is produced in the Philippines without the use of machinery; the planting, cultivation, and harvesting being done entirely by hand. Under such conditions a greater area can scarcely be handled by the average family. A lack of significant diversification in farming or of rotation of crops provides two high "labor peaks," planting and harvesting, that take the entire energy of a rice community to negotiate. *Morcellment* of land has gone on in the Islands for countless generations through inheritance. Primogeniture, neither legal nor customary, has ever obtained in the Philippines. Inherited land holds a high sacrosanct character with the farmers and is seldom sold except under financial duress. The gregarious character of the people, the popular barrio system, the lack of suitable communication between the public domain and the markets for its potential production, inefficiency in the administration of the Government's survey and title mechanism are all partly responsible for continued small holdings.

CROPS

[Statistical Appendix, Section II]

The intention of the surveys was limited to rice tenancies and in consequence no other crop of considerable extent was to be expected. In tropical countries in general, and the Philippines is no exception but on the contrary one of the best examples, crop areas follow distinct topographical and climatic zones. Even where a particular zone is optimum for two or three crops, custom and conservatism act strongly against diversification. Over considerable lengths of time there may be some shifting. The shifting of crops from year to year as it has affected rice production in the Philippines is treated by Hester (24) where it is pointed out that rice cultivation has been forced to suffer the principal diminution of area in favor of sugar and other war time "bonanzas". The crops found in the surveys are shown in detail in Section II of the statistical abstract and need only be summarized.

Rice.— 91.8 per cent of the effective area was planted to rice. In San Miguel and Santa Rosa rice was the sole crop. A second crop of rice was produced on 29.5 per cent of the cultivated area in Santa Rosa and on about three per cent of the cultivated area in Calasiao.

Maize.—Maize occupied 2.8 per cent of the effective area of all surveys. It was grown in Tigbauan, Hagonoy, Calasiao, Naic, and Bay as a first crop and to a very limited extent, three hectares, in Calasiao as a second crop.

Sugar.—Sugar was produced on 3.9 per cent of the effective area and was confined to Tigbauan, Hagonoy, Calasiao, and Naic.

Zacate.—Zacate covered 11.4 hectares in Bay or 0.6 per cent of the total effective area of all surveys. This comparatively profitable crop is grown for sale as green forage grass for horses. It affords a diversification of questionable value in very limited areas in proximity to Manila.

Vegetables and fruits.—In Tigbauan, Calasiao, Aparri, and Bay, together, 17.8 hectares were devoted to the production of vegetables (gabi, ubi, tomatoes, and beans) and fruit (bananas and guavas) for home consumption. Garden and orchard cultivation occupied but 0.9 per cent of the total effective area.

Rotation of crops.—No rotation of crops was discovered either as regards the limited second crops or on a two or three year schedule.

Diversification of crops.—The diversification on the rice tenancies investigated amounted to the insignificant extent of 8.2 per cent of the effective area. Although the Census Office (6) provides no schedules from which the degree of diversification and rotation may be adduced, it is a matter of common knowledge that they are negligible factors in all Philippine agriculture. The Philippine Islands are in the primitive one-field-system of agriculture, a system abandoned in the principal agricultural countries of Europe nearly 500 years ago.

TENURE

[Statistical Appendix, Section III]

It would be indefensible to consider tenancy without closely scrutinizing the length and character of tenure. For the surveys, this consideration has been summarized under three points.

Length of tenure.—The length of tenure is an important consideration from two standpoints: First, it defines the residential stability of the rural community; and secondly, it bears upon the whole field of farm management. Tichnor (25) offers "next to the division of income between labor and capital, the most important feature of the contract is the length of tenure it provides." In Europe, generally, exists a firm policy of long-term leases and in North America quite as strong a tendency to short-term leases. In the Philippines, length of tenure is not a matter of contract. The tenant remains as long as he and the landlord both agree, it being understood that the tenant must remain throughout the year's crop.

The average length of tenure for the reporting surveys was 6.8 years. The averages for individual tenants varied from 0.7 to 50 years and for separate surveys from 3.8 years, the average for both Naic and Bay, to 14.8 years, the average for Santa Rosa. The percentage of all tenants of less than 5 years tenure was 69.2. It appears significant that the two surveys which had the longer average lengths of tenure, Santa Rosa and Hagonoy, are the two which had the larger average areas.

Poly-tenantry.—Having in mind the limited areas of Philippine tenancies, it is not surprising that a considerable number of tenants were found who undertook to operate additional tenancies under neighboring landlords. Of the six surveys reported on this point, 18 per cent of their tenants were operating under more than one landlord. The condition is indicative of a desire for a larger area wherever available. As would be expected, where the average area was low,

the percentage of poly-tenantry was also low. The same causes, lack of land and competition for the holdings, would proscribe both increase in average area and additional tenancies.

Reasons for leaving former tenancies.—An attempt was made to gather information from tenants as to reasons for relinquishing any former tenancies they may have held. The data was limited for several reasons: (a) The investigation on this point was confined to five of the surveys; (b) For many younger tenants the present holding was their first; (c) Several had engaged in occupations other than agricultural; and (d) Many refused information on the point. Reluctance in reporting former tenancies was frequently due to the fact that the tenants, kept continuously in debt at usurious rates to their previous landlords, had taken "French leave" without satisfying their indebtedness, had moved from a great distance, and had further hidden their identity by changing their names. Of all reasons advanced for leaving former tenancies almost one-third was "controversy with landlord." This was the general cause in Hagonoy and Naic, communities where tenant resistance and passive rebellion have been matters of Insular concern for the past two years.

One fifth of the reasons advanced was "area too limited." This reason was largely advanced by tenants at Bay. Further investigation showed that practically all of these tenants had been "imported" from Bigaa, Bulacan, where according to Census Office (6), the average area of farms was 1.5 hectares. At Bay these tenants who had left Bigaa because of small areas were enjoying holdings averaging 2.1 hectares

A third very significant reason was "abolition of tenancy." Within recent years according to Hester (21) there has been a marked tendency to enclosures on large estates, especially in Central Luzon (provinces of Bulacan, Pampanga, Tarlac, and Pangasinan.) The increasing importance of sugar production under a proprietary system is responsible for the movement.

A "lack of work animals" was frequently advanced. Any one familiar with the ravages of rinderpest among the native work animals will readily appreciate this cause, the surprise is that this reason was not more general. "Poor soil" was another noteworthy complaint against former tenancies.

CONTRACTS FOR LOWLAND RICE

[Statistical Appendix, Sections IV & V]

Tichenor (25) quotes W. J. Spillman as follows:

> The most important feature of tenant farming from the farm-management view-point is the character of the contract between landlord and tenant. This is a very real problem to every one who rents land, either as owner or as tenant. The owner naturally wants all he can get out of his land and improvements; the tenant just as naturally wants all he can get for his labor.
>
> The one great fundamental point on which all other details of the contract hinge is the proportion of the income of the business that should go as remuneration to labor and the proportion that should go as interest and depreciation on the invested capital. When this point is once determined it is easy to work out the remaining details, no matter what proportion of the working capital is furnished by the landlord and tenant respectively.
>
> The proportion of the farm income that should go to labor will vary with the type of farming and with the fertility of the soil. This point is now under investigation by the Government Office of Farm Management, and it begins to appear that it will be possible to arrive at a few general principles that have a very wide application and that will furnish a satisfactory solution for this vexed problem.

The use of the word "contract" in regard to Philippine tenancies is scarcely technical. A contract in this paper is a series of implied customary covenants which are inferred from: (a) Limited verbal agreements; and (b) Relations of one party to another as has existed either in the community or on the estate "so long that the memory of man runneth not to the contrary".

In reality the system of Philippine tenancy was established when the Islands operated under Spanish code law, but always tenancy has borne up under the adversity of loosely applied common law procedure. The Agricultural Section of the Institute of Social Reform, Madrid, has only the following under *Legislation* (26).

> Codigo Civil, *Article 1,579.*—The letting of land on share tenancy (aparceria) for cultivation, stockbreeding, or for manufacturing or industrial establishments is governed by the provisions relating to partnership agreements, by the stipulations made between the parties and, in default of these, by the custom of the district.

On the contrary, in true common law countries, such as England, there is provided a special code for land tenure and explicit contract is the rule.

In the Statistical Appendix, the principal types of customary contracts are listed. The study is limited to the terms regarding rice cultivation. Terms regarding the minor crops presented an elaborate variation, there being frequent differences in this regard even on the same estate. The minor crops seem to have been the only "bargaining point" between the landlord and prospective tenant. Neither does the list include contracts applying to less than ten tenancies. The unusual contracts are grouped as "special". The number of these special contracts was a little over 10 per cent of the entire number.

The typical contract.—From a tabulation of the various types it is possible to present the following typical contract which applies roughly to 70 per cent of all tenancies studied.

Land: Furnished by landlord

Labor
- Pre-harvest by tenant
- Harvest by tenant and third parties
- Post-harvest by tenant

Capital
- Implements by tenant
- Work animals by tenant
- Seed advanced by landlord

Division
- *Gross product*
  - 10 to 17 per cent to harvesters
  - Seed returned to landlord
  - 83 to 90 per cent less seed to net product
- *Net product*
  - 50 per cent to landlord
  - 50 per cent to tenant

Terminology.—Before discussing contracts further it is necessary to define certain terms used both in the descriptions in the Statistical Appendix, the typical contract above, and in this discussion. *Pre-harvest labor* includes every process from the preparation of the land to and including the protection of the crop until it is to be cut. It includes making and caring for the seed bed and the paddy,

caring for work animals, fencing, scaring off birds, rats, and locusts. *Harvest labor* is restricted to the process of cutting the standing grain, fastening it in bundles, stacking, and threshing. *Post-harvest* labor includes the hauling of the landlord's share to his storehouse or to a mill. *Gross product* refers to the total palay, (unhulled rice) immediately after threshing. *Net product* applies to the palay, which after deduction of the share of third party harvesters and of the advanced seed, if such deductions are made, remains for division between landlord and tenant. Sometimes a helper or animal owner is a factor in division of net product.

Deviations from typical contract.—The more important deviations may be briefly stated as follows:

In 139 tenancies in Naic and in 78 in Santa Rosa, outside group labor assisted in the transplanting as well as in the harvest. In Naic this was due to the extensive use of unpaid exchange labor, in Santa Rosa the transplanters were also the harvesters and received up to 25 per cent of the gross product as compensation for both tasks. The use of third party labor in transplanting at Santa Rosa is due to the comparatively large average area of the tenancies, 4.6 hectares.

In 19 holdings at Santa Rosa, a "helper" furnished the implements and shared both the work and tenants net income equally. The cause for this was large areas.

In 110 holdings, 107 in Bay and 3 in Tigbauan, the landlord furnished the work animals; 86 of such units in Bay received 50 per cent of the net product regardless of the fact that the landlord furnished the animals. These 86 units were held by "imported" tenants. It appears that this divergence from the typical contract. favorable to the tenant as it is, is due to the fact that in the Bay region there is a shortage of tenants, and landlords are forced to go afield for their tenants and offer easier terms. Fourteen of the Bay units in which the landlord furnished the animals suffered a compensating variation in division, receiving only one third of the net product. The remaining 10, 7 in Bay and 3 in Tigbauan, suffered a similar reduction in division, the tenants receiving but 40 per cent of net product.

In 105 cases, all in Aparri, the tenants furnished their own seed. In 210 cases, 139 in Naic and 71 in Calasiao, the landlord furnished the seed outright, not requiring any return from gross product.

In 78 cases, all in Santa Rosa, the harvesters received from 10 to 25 per cent of the gross product rather than the 10 to 17 per cent prescribed as typical. This greater range was due to the fact that the harvesters in these same 78 cases also assisted in the transplanting of the rice. In 115 cases, 105 in Aparri and 10 in Bay, due to a shortage of labor, the tenants were forced to offer 20 per cent of the gross product to outside laborers who worked as harvesters.

In the matter of division of the crop, variation from the typical contract was noted above in 24 of the 110 holdings on which the landlords furnished the work animals and compensated themselves for their capitalistic enterprise by reducing the tenants' shares to 40 or 33⅓ per cent of the net product. In the case of 40 tenants at San Miguel, all of whom were under the same landlord, the tenants furnished the work animals, as is typical, but received 60 per cent of the net product. Likewise, 105 tenants in Aparri who furnished their own animals received 66⅔ per cent of the net product. Aparri is adjacent to fine open public

land, many of its tenants are gradually going out into the domain as is shown by the relatively high degree of land ownership among Aparri tenants (Statistical Abstract, Section XIII). There is no doubt that this fact induces more favorable terms from the landlords.

Perhaps the most notable exceptions to the typical contract were found in Naic and at Santa Rosa. These variations were the *buis*[26] in Naic and *canon*[27] in Santa Rosa, arising from an attempt to force the tenant to help the landlord in the purchase of his land. In both regions the land is part of the Friar Estates purchased by the Insular Government in 1907 from certain orders of the Roman Church with the idea of re-parcelling and selling it to the tillers of the soil on a twenty year payment plan. How far short the Government's plans have fallen is shown by the fact that probably over 80 per cent of the parcels are under tenancy today. Only a few of the actual "tillers of the soil" were able to make first payments and so the lands fell into the hands of merchants and artisans. The few original tenants who were purchasers, after a few payments had been made, elevated themselves into the landlord class, moved to the near by *poblacion*,[28] went into trade and placed their holdings in the hands of tenants. Then these government-subsidized landlords with a naïveté that challenges comparison, proceeded to modify the customary contract so that, although they retained the usual percentage or share of the net product, about two thirds of the annual payment for the land was shifted to the tenant. Thus furnishing economists the rare and edifying spectacle of tenants purchasing two thirds of the area of their tenancies for the landlords and at the same time paying them half of the crops as rent.

The *buis* was levied on the basis of a given number of cavans for each cavan of seed planted; the best land required a payment of 15 cavans of palay for each cavan planted and the poorest land required a payment of four cavans for each cavan planted. For the survey at Naic the collection amounted to 1129 cavans on 288 hectares or an average of about three cavans per hectare. In 1921 and 1922, the *Magsasaka*[29] and *Union de Aparceros de Filipinas*[30] were backing a straight-forward and forceful resistance against further collection of the *buis*. Further consideration of this "rebellion" is given under *Tenant Aggression* on page 403.

The case in Santa Rosa was more open. A *canon* of ten pesos per hectare was levied on every holding and paid in cash. No resistance has yet been manifested at Santa Rosa, perhaps because of the fact that the Santa Rosa district is comparatively favorable to the tenants as shown by the fact that the survey there ranked first in point of average income per tenant. (Page 428.)

Miller's thesis.—Mr. Hugo Miller (4) presents the following thesis relative to tenant contracts, "The division of the crop therefore depends on who owns the carabao. If the tenant possesses a carabao he gets two thirds of the rice crop, and the landlord one third; in other cases the owner usually gets two thirds, and the tenant one third". This generalization did not hold good for the surveys

[26] Tagalog, a special collection of the landlord based on quantity of seed planted.
[27] Spanish, literally an ecclesiastical decree now used to refer to a special tax levied by the landlords on the former friar estate at Santa Rosa.
[28] Spanish, the center of a municipality.
[29] Tagalog, literally, "farmers". A recent tenant organization.
[30] Spanish, "Union of Share Tenants of the Philippines."

here presented as the preponderant division was half to the landlord and half to the tenant with the latter furnishing the carabao.

The Hagonoy Ordinances.—In only one instance was anything in the nature of a written instrument between landlord and tenant discovered. One landlord at Hagonoy had a drawn form which he required every tenant to sign. As will be seen, this document did not essentially involve the basic terms of agreement but was a compilation of ordinances over and above the customary contract. The paper faithfully reflects the general rules of tenant behavior throughout the various surveys and is here given in full from Santos (18) who translated it from the original Tagalog.

NOTICE

In order to promote good understanding between us, I hereby make the following regulations to be strictly followed by all my tenants and prospective tenants. It will be considered approved and accepted on the part of my tenants when after reading and understanding these regulations they continue to work on their land, they therefore will be held responsible for the observance of these rules.

Article I.—It is necessary that every one of my tenants should own carabaos in proportion to the size of his holding. Such work animals should not be sold, or exchanged for other animals, or work animals, without my consent so that I may know whether that particular tenant can continue to work as an efficient tenant.

Article II.—The parcels or yards assigned to every tenant cannot be transferred, subleased or given to other persons in sub-tenancy. Any one found guilty of such action will be deprived of his share of the crops on the parcels or yards.

Article III.—The bamboo and other valuable trees growing on the tenant parcels or yards near their houses are excluded from the yearly agricultural crops. They are exclusively for the owner of the land. Any tenant who cuts, sells, or picks fruit of the said trees without my knowledge will be required to pay a fine to be imposed by the owner of the land. However, my tenants are allowed to grow any fruit trees or bamboo, within their own parcels if they so desire, with my consent, in which case they may have an equal share with me of the fruit or trees raised.

Article IV.—The seed to be grown must always be ready at the time of planting, and any negligence on the part of the tenants will deprive them of their work. In dividing the crop raised, no allowance for seed is given except for rice and corn.

Article V.—It is strictly prohibited for any one of my tenants to offer himself as tenant to another landlord, or engage in any other business that will require him to be more than four days absent from his parcel at any season of the year, or more than two days during the preparation of the land. Any violator of this rule will lose the privilege of being my tenant.

Article VI.—Any garden product or fruit grown should not be sold until after the crops to be sold will have been inspected by me or my representative. The landlord's share will be deposited with his representative.

Article VII.—All of my tenants having houses built on my lands should plant fruit trees, garden plants, or any possible crops on any available space around the houses.

Article VIII.—Tenants are not allowed to raise live stock or poultry without my written permission and even with my consent the tenant concerned will answer for the possible damage of the crops in the fields. Because of unavoidable damage caused by these animals, I hereby announce that one of the offspring of each kind of those animals, will be chosen by the landlord for his share. It will be considered unjust, and disloyal on the part of the tenant to keep for himself without the knowledge of the landlord any one of these animals, or transfer the same to another place.

Article IX.—The tenant who has wide and long paddies on his lowland holding or any vacant space on an upland parcel is required to plant anything that will yield something to keep the land in production. Any tenant found handicapped shows his incapability to handle his work, in which case the landlord may either dismiss him from his holding or lessen the area of his holding.

Article X.—All tenants may be required to work together for the benefit of one tenant or for the advantage of all the tenants within my lands, in which case prompt service is expected from each tenant. It is understood that the required tools needed for the group work must be provided by the tenants.

Article XI.—Any tenant found dishonest in withholding a portion of the crops under tenancy which have not yet been divided will be summarily dismissed from his holding.

Article XII.—Any house built within the boundary of my land aside from the tenant's house for himself and his family will be subject to the usual rent. I strictly prohibit my tenants and those not my tenants who live in a house built on my land to organize or join any secret society prohibited by the government or house such people as may endanger the community. I do not want to see any one of my tenants go to the cockpit, or gamble. The violator of this article will lose the privilege of being my tenant.

Article XIII.—My tenants are required to report to me immediately when I go to their fields. They must submit reports about their holdings, must be ready to answer any inquiry of the landlord and to receive instruction from me for their own welfare.

Article XIV.—I, your landlord, am responsible and am ready to answer for any trouble of my tenants about their parcels except when an unavoidable circumstance happens and the land is transferred to another person or sold to another landowner.

In spite of the fact that you have given me the full power to judge and punish any violator of these regulations, yet, I transfer this privilege to you: to elect a committee of three tenants, one to be called "president" and the other two "members," whose duty will be defined by me. I propose this plan in order to teach you how to be members of a society under a constitution, to debate, to judge, and to be good citizens.

I affirm.

(*Signature of landlord*) (*Signature of tenant*)

Classification of the typical contract.—Reviewing Miller's classification as quoted in the *Introduction*, it will be found that the typical contract and consequently the system operating in 70 per cent of the tenancies surveyed is "the *kasama* share system" Those deviations, principally at Bay, in which the landlord furnished the animals are not true *kasama* units but what would be termed in English, "croppers".

SUPERVISION OF LANDLORDS

[Statistical Appendix, Section VI]

A common opinion exists, and is credited by Miller (4), that an advantage of tenants over peasant proprietors is found in the fact that the tenant enjoys the supervision of the landlord, who, being more literate and experienced than either tenant or peasant, is assumed to possess better knowledge of farming. Laying aside the question of whether the landlord does possess the superior skill, the question of degree of supervision actually practiced was investigated. Three types of supervision were distinguished.

Complete supervision.—Complete supervision was interpreted to mean that the landlord or his agent dictated the dates and methods for every process in rice culture and visited the tenancy to see that his orders were carried out. Of all surveys, 43 per cent of the area was found to be under complete supervision. One survey, San Miguel, was entirely under such supervision. In this connection, it must be stated that the San Miguel survey included but one landlord, which accounts for the similarity of conditions in the 40 units of the survey. Tigbauan and Santa Rosa enjoyed complete supervision on their greater area. In Aparri, no portion of the area was found to be under complete supervision.

Intermittent supervision.—The intermittent type of supervision was applied to those tenancies in which the landlord or his agent made between five and ten

visits annually for the purpose of inspection. No dictation of dates or methods was made under this type of supervision. A part of the area of each survey, except San Miguel, and 35 per cent of the total area of all surveys was found to be under intermittent supervision. The major portions of the area of Hagonoy, Naic, and Bay surveys were so classified.

Ineffective supervision.—Under the designation, ineffective, were included all tenancies in which the landlord's activity was limited to checking the harvest and verifying his share, either personally or through an agent. Ineffective supervision applied to 22 per cent of the area of all surveys. A fraction of the area of each survey, except San Miguel, was ineffectively supervised. The major portions of the areas in Calasiao, 64 per cent, and in Aparri, 98 per cent, were so classified.

Agents and foremen.—The landlords rarely hire salaried officials in the capacity of agents. Only at San Miguel was such an entity found. In the majority of cases a trusted tenant is attached by a favorable special contract and assigned the duty of supervision. In other cases the landlord himself or a relative assumes the direct responsibility. There seems to be a great deal of carelessness in supervision but relatively little absentee landlordism. Disputes between landlords and tenants are frequent and they all naturally arise in those areas under intermittent and ineffective supervision. Wherever rigid or complete supervision exists, there is a distinct tendency towards the manorial type; in general, better agriculture and less prosperous but better disciplined tenants. It is interesting to note that in the only region in which tenant resistance and anti-landlordism was found, in Naic, the intermittent type of supervision predominated.

TENANT'S FARM LABOR TIME

[Statistical Appendix, Section VII]

By far the chief economic function of the tenant and his greatest investment is labor. For Philippine rice districts, labor is a family affair. The women and children assist in every process except the preparation of the land. The question of family labor was investigated in seven of the eight surveys: Tigbauan, Santa Rosa, Hagonoy, Calasiao, Naic, Aparri, and Bay. The data were taken in labor-days, but inasmuch as the length of the labor-day varied for different processes and for different regions, in each survey the labor-days were reduced to labor-hours. In all processes the family labor was included, adult men being weighted at 1, adult women at $\frac{3}{4}$, and youths and children at $\frac{1}{2}$, in order to arrive at comparative values. Outside labor in harvesting was not included. The results are briefly summarized for the different processes arranged chronologically.

Preparation of the land.—Preparation of the land to receive the crop was the heaviest process and required of each tenant surveyed an average of 275 hours per annum; for each hectare, 116 hours per annum.

Planting and transplating.—The making of the seed bed, planting the seed therein, and in due season transferring the seedlings to the paddy required of each tenant surveyed, including his family, an average of 50 hours per annum; for each hectare, 21 hours per annum.

Cultivation.—Labor for the cultivation of a growing crop was insignificant in San Miguel, Hagonoy, Calasiao, and Aparri. The average time devoted by each tenant surveyed to cultivation was 93 hours per annum; for each hectare, 39 hours per annum.

Harvesting.—Harvesting was found to be the second heaviest process of the farm year in rice culture under Philippine methods. The bulk of the labor was performed by third parties, either strangers paid in share, or neighbors recompensed on an exchange schedule. Only the supervision and incidental labor was undertaken by the tenant. The tenants' families, however, assist regularly. Including repayments of exchange labor, the average harvesting labor for each tenant surveyed, including his family, was 214 hours per annum; for each hectare, 91 hours per annum.

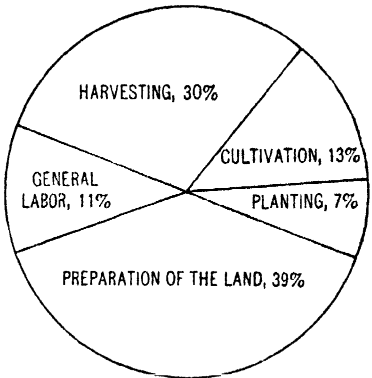

Fig. 1.—Division of labor by processes on 790 Philippine rice tenancies.

General labor.—The general labor on the average, one crop, unstocked Philippine farm is not heavy. Each tenant surveyed, including his family, averaged 73 hours per annum; each hectare, 31 hours per annum.

Total labor.—Prior to this investigation, Hester (27) wrote on a basis of general observation, "The average tenant and peasant proprietor of the Philippines has not the land area, capital in the way of animals and implements, nor the diversity of crops which will permit him to put more than 500 hours of real labor per annum per hectare on his holding. Such a condition can not be relative to agrarian prosperity". The estimate quoted seems too liberal when compared with the results of the surveys. For all surveys the average labor time per annum for each tenant was 705 hours and for *each hectare, 299 hours.* Figure 1 shows the division of the total farm labor based on the averages of all surveys reporting.

Seasonal distribution of labor.—Of equal importance with the distribution of labor by processes is the seasonal distribution. On a one crop, unstocked farm, the labor-peak is a very limiting factor. It is determinant of possible area and consequently of yield, income, and investment. The beginning of the farm year on Philippine rice farms is determined by the coming of the first heavy rains after which the paddies may be plowed and harrowed to receive the seed. The variety of rice planted controls the interval between planting and harvest. For the seven surveys these factors varied greatly as regards the actual months for the various processes, although the intervals agreed. For this reason, in Figure 2, the months are numbered rather than named. It will be seen from an examination of the figure that the first month and the first half of the seventh

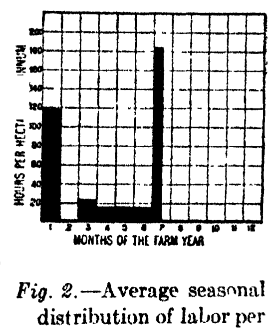

Fig. 2.—Average seasonal distribution of labor per hectare on 790 Philippine rice tenancies

month, the seasons of preparation of land and of harvesting, respectively, present heavy labor-peaks, while during the other months there appears an unwholesome enforced idleness.

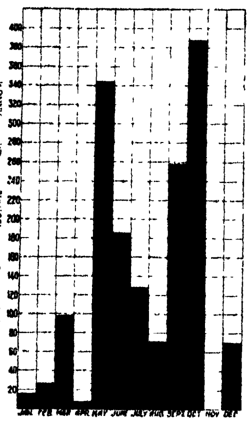

Fig. 3.—Seasonal distribution of labor per hectare on a 32 mow (2.15 hectares) farm near Wuhu, Anhwei, China, with a four crop diversification. After BUCK.

Comparison of seasonal distribution in the Philippines and China.—Comparison of seasonal distribution of labor on the undiversified hectare in Philippine rice regions with the seasonal distribution of labor on the four-crop diversified hectare of the Nanking China rice region as determined by Buck (28) is shown in Figure 3.

The Chinese farm had the following diversification: (a) Winter and early spring, 20 mow of rape, 5 mow of wheat and 2 mow of barley; (b) Summer, 32 mow of rice.

From the comparison, three facts may be emphasized. (a) The Chinese farm received a total of 1500 hours of labor. As it offered two crops a year, the one-crop labor figure may be placed at 750 hours which is more than two and half times the annual farm labor per hectare per annum on the Philippine one crop, non-diversified farm. (b) Due both to the two crop and diversification features, but principally to the latter, the Chinese farmer was more evenly occupied throughout the year. (c) Whereas Buck (28) presents the diagram as an illustration of *poor* distribution of labor for China, it is ideal as compared with the prevailing distribution on Philippine rice tenancies.

Although no seasonal distribution chart is provided, Perris (29) gives 200 to 300 days as the labor requirement on one hectare of rice land in Japan, presumably on two crop areas.

Relation of labor time to area.—That there is a distinct relation between labor time and area is shown by the following facts: (a) Santa Rosa and Hagonoy had the lowest averages for labor time per hectare per annum and the highest average areas; and (b) Calasiao had the highest average labor time per hectare per annum and the lowest average area. The indication is strong that the greater the area, the less the labor per hectare. There would, of course, be a point of diminution if the range were carried far enough, but the results are sufficient to show that the larger areas on Philippine rice tenancies are more economical of labor than the smaller areas.

ANIMAL LABOR

[Statistical Appendix, Section VIII]

The native work animal, carabao or cattle, in Philippine rice farming is an indespensable adjunct to the manual labor of the tenant and his family. The animals are used in preparing the land, on the threshing floor, and for transporting the palay to granaries and to market. Writers commonly point to Philippine rice production as a hand-labor process. This must be modified to include the ever-present carabao or bullock.

In the surveys reported on this point, 935 animals each performed an average of 220 hours of labor per annum, which amounts to 355 hours for each tenancy, or 148 hours per hectare.

A comparison of the average animal labor per hectare per annum with the average farm labor of tenant and family per hectare per annum shows that for each hour of human labor there was, approximately, one-half hour of animal labor. The condition emphasizes the indespensable character of animal labor in the economy of rice farming.

TENANT'S FARM INVESTMENT

[Statistical Appendix, Section IX]

In all systems of tenancy, the primary allocation of the factors of production is that the landowner furnishes the land, and the tenant, the labor. The third factor, capital goods, may be furnished by either the tenant or the landlord or by the two in conjunction. This principle of allocation is briefly and well discussed by Turner (30). So far as the Philippines is concerned, as the typical contract indicated, the tenant is also the capitalist furnishing the implements and in most cases the work animals. An investigation involving the extent of farm capital goods was made in five of the surveys: Santa Rosa, Hagonoy, Calasiao, Naic, and Aparri. Accurate inventories were made and careful evaluations allowed. The details of investment are given in the Statistical Appendix and the discussion is limited to a presentation of the more general facts.

Dwellings and yards.—The building investment was lodged principally in the dwelling house of the tenant and his family, usually located in a barrio adjacent to the holding. The houses are raised high from the ground on posts, permitting the space beneath to serve as storage room for farm products and tools, and stabling room for work animals and such other live stock as the tenant might own. The yards are small, rarely allowing for kitchen gardens. Their value is included with that of the houses. Of the 580 tenants who were surveyed for investment, 570 owned houses, 520 owned the lots on which their houses were located, 70 having been furnished yards by their landlords. The average value for each dwelling, including yard, was ₱122. The average value for each tenant was ₱120; for each hectare, ₱50. The investment in dwellings and yards averaged 35 per cent of the total investment.

Farm buildings.—Due to the paucity of live stock and the primitive character of the implements used in the tenancies, as well as the favorable place of storage afforded under the high floor of the dwelling, farm purpose buildings were rarities. As rice is generally sold to the mill immediately after harvest, few granaries were discovered. Fifty-two tenants, out of 580 surveyed, each possessed one general purpose farm building the average value of which was ₱52. The average value for each tenant of the reporting surveys was ₱5; for each hectare less than ₱2. Farm buildings constituted less than one per cent of the total investment.

Implements and vehicles.—The usual assortment of implements found on the tenant holding consists of a rude, native built plow constructed by the tenant himself and consisting of a main crotch and part of the branches of a hard-wood tree finished with a shoe of grey iron and a wooden coupling for the animal; a very simple harrow in the form of a gigantic rake having long pegs, usually of wood, driven through two or more sturdy cross bars; and several bolos and harvesting knives. For conveyance there is the cart with solid wheels, except for the axle, entirely of native construction; or failing this and where no roads lead to the holding, a sledge with a bamboo body lashed with filets of rattan to hard

wood runners. Summarizing the investment in all types of implements and vehicles for the five surveys, the average value for each tenant was ₱27; for each hectare, ₱11. Implements and vehicles accounted for but eight per cent of the total investment.

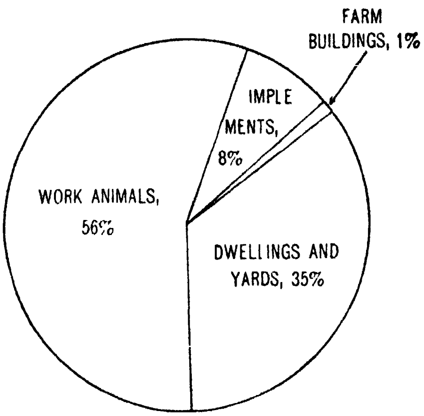

Fig. 4.—Proportions of investment in different classes of capital goods on 580 Philippine tenancies.

Work animals.—The companion of the rice farmer is his carabao (water buffalo). His importance was anticipated under *Animal Labor.* No type of work animal other than the carabao was met with in the surveys. The 580 tenants of the surveys concerned, owned 935 work animals which gives an average for each tenant of 1.6 animals; for each hectare, .7 of an animal. The average value of each animal was ₱120 which amounts for each tenant, ₱192; for each hectare, ₱80. The value of work animals was 56 per cent of the average total investment.

Total investment.—The average total investment was ₱345 for each tenant or ₱143 per hectare. The allotment of the average total investment among the different items is indicated in Figure 4 on a basis of percentages of the whole.

Relation of investment to area.—The five surveys for which investment data were collected are arranged as follows to show the co-relation between average total investment and average area:

Five surveys in descending order of average areas:	*Five surveys in ascending order of average total investment per hectare:*
Santa Rosa	Santa Rosa
Hagonoy	Hagonoy
Naic	Naic
Aparri	Calasiao
Calasiao	Aparri

From the above arrangement it may be concluded that the greater the area, the less the average investment need be. The data forcefully argues for the relative economy in investment of the larger areas. The reasons for the interchange of Calasiao and Aparri in the parallel columns is artificial. In Aparri the value of dwelling houses was exceptionally high, being ₱161 as against the average of ₱122, while in Calasiao, the value of dwelling houses was exceptionally low, being ₱35 against the average of ₱122. Comparative luxury in dwellings is incidental to general farm conditions.

TENANTS' ANNUAL FARM INCOME

[Statistical Appendix, Section X]

It is realized that the evaluation of income is a difficult point in investment. Variation in judgment of the three persons concerned—tenant, landlord, and investigator—is apt to be wide. Reluctance and ignorance on the part of the tenant and reluctance and poor bookkeeping on the part of the landlord are sources of error. Regional fluctuations in yield and price of farm products defy com-

parison of the data from one survey with the data from another. Finally, yearly fluctuations in prices throw doubt upon the value of anything less than ten-year averages. The figures collected are given more as a starting point than as an end in themselves. All conclusions drawn from them should be considered tentative.

The farm income.—Accepting, for the time, the figures as given for tenants' annual farm income it was found that the average for each tenant amounted to ₱189; for each hectare, ₱80. The highest average per hectare was recorded for Naic, ₱112, and the lowest for Hagonoy, ₱61.

Labor income.—Farm income includes two elements: (a) Return on investment including both interest and investment; and (b) Labor income. The average investment per hectare was ₱143. A fair rate of interest in the Philippine Islands is eight per cent per annum and a fair general depreciation figure is 12 per cent per annum. For the average investment the return would therefore be ₱28.60 per hectare per annum. Taking the investment return from the gross income, ₱80, there would be left ₱51.40 as average net labor income per hectare per annum.

Relation of income to labor time.—The average labor income per hectare per annum being ₱51.40 and the average labor time per hectare per annum being 299 hours, it appears that the tenant received an hourly wage of approximately 17 centavos. The rate compares favorably with other wages in the Philippine Islands. According to the Director of the Bureau of Education (31) the average monthly wage of municipal school teachers in the Philippines in 1920 was ₱37.86. The labor time of these teachers averaged 100 hours a month. The wage rate of the municipal teacher, therefore, averages 38 centavos per hour. Bureau of Commerce and Industry (9) gives 65 centavos as the daily cash wage for agricultural laborers. The day is reckoned at seven hours in agriculture which gives an hourly wage of about eight centavos. Master carpenters averaged 36 centavos an hour, journeymen carpenters, 24 centavos an hour. In general, the farm tenant received double the hour wage of farm laborers and half the hour wage of school teachers and master carpenters.

Relation of income to area.—The six surveys for which farm income data were recorded are arranged as follows to show the correlation between average farm income per hectare and average area:

Six surveys in descending order of average areas:	*Six surveys in ascending order of average farm income per hectare per annum:*
Santa Rosa	Hagonoy
Hagonoy	Tigbauan
Tigbauan	Santa Rosa
Naic	Calasiao
Aparri	Aparri
Calasiao	Naic

The parallel arrangement above shows that the three surveys which had the larger average areas had the lower average incomes, whereas the three surveys which had the smaller average areas had the larger average farm incomes. The conclusion is that, within limits, the larger areas are less intensively cultivated and consequently yield a lower income per hectare.

Comparison with Hill and Moe's estimates.—Quite the most conscientious attempt to estimate income on rice farms in the Philippines which has yet appeared is that of Messrs. Percy Hill and Kilmer O. Moe. Mr Hill has for many years successfully managed his large rice estate at Muñoz, Nueva Ecija, under a native tenant system and Mr. Moe was for over ten years director of the Central Luzon Agricultural School located at Muñoz and devoted largely to empirical instruction in rice growing. These gentlemen (14) give the following annual incomes on rice farms.

1914	₱113.30
1915	114.75
1916	123.45
1917	177.00
1918	193.90
1919	280.00

The above estimates average ₱167 per annum. The writers failed to give the average areas and located the estimates as applying to "the northern part of Central Luzon". Two provinces would be involved, Pangasinan and Nueva Ecija. Census Office (6) gives the average area of rice farms in Pangasinan as 1.12 hectares and in Nueva Ecija as 4.81 hectares. Consequently, applying the average of Hill and Moe's estimates to Pangasinan, the income per hectare per annum would be ₱149; applying the average of the estimates to Nueva Ecija, the income per hectare per annum would be nearly ₱35. The average for the surveys under consideration was ₱80 which falls between the two figures computed from Hill and Moe and very near the mean.

JUSTIFICATION OF THE TYPICAL CONTRACT

After having set forth the typical contract, the tenant's labor time, investment, and farm income, it is possible to work out a comparison of the theoretical net returns. The attempt at justification will be based on hectare-annum data brought out in the foregoing sections of the discussion.

Landlord's cost.—The legitimate costs of the landlord may be conservatively estimated as follows: (a) The value of one hectare of standard Philippine rice land at market rates would be ₱300. Eight per cent, the bank rate of well secured Philippine farm mortgages, may be taken as legitimate rent, which produces the amount of ₱24. (b) The taxes would not exceed ₱12.50 per annum. (c) The landlord's supervision would be abundantly repaid at ₱10. (d) The interest on advanced seed would be more than covered at ₱2. (e) The sum of landlord's cost would be, therefore, ₱43.50 on an investment of ₱300.

Tenant's cost.—Turning to the typical tenant's cost, it may be construed as: (a) Return on investment, including interest and depreciation, ₱28.60 (page 391) (b) Return on farm labor of himself and family, using the Bureau of Commerce and Industry (9) figure of eight centavos an hour for agricultural laborers (page 391)and the total hours, 299 (page 387) would be ₱23.92. (c) The two returns would amount to ₱52.52, as tenant's cost on an investment of ₱143.

Gross incomes.—The average gross income was ₱80 (page 391) for the tenant. Under the typical contract, the figure would be identical for the landlord.

Net incomes.—Subtracting landlord's cost from his gross income would leave ₱36.50 as landlord's net income. The same computation for the tenant would leave ₱27.48 as the tenant's net income.

Comparison of net incomes to investments.—The final justification should rest on the relation of net income to investment. The landlord's net income, ₱36.50, was 12 per cent of his investment, ₱300. The tenant's net income, ₱27.48, was also 12 per cent of his investment, ₱143.

There were 110 holdings (page 382) in which the deviation from the typical contract was in favor of the tenant in that the landlord was required to shoulder the heaviest item of investment, animals, without compensating himself through the reduction of the tenant's share. On the contrary, there were 81 tenancies in Santa Rosa and 151 in Naic (pages 382-3) where the deviations resulted in a radical advantage to the landlord, in that he collected an extra *canon* or *buis* without compensating increase of tenant's share.

From the foregoing it may be concluded that *the typical contract which applied to 70 per cent of the tenancies surveyed was equitable and just,* although there were twice as many cases in which the deviation from the typical contract was in favor of the landlord as there were cases in which the deviation was in favor of the tenant.

It is not possible to charge the faults of Philippine rice tenancy to the contract, they must lie in more fundamental, though less sensational, factors.

SECONDARY OCCUPATION OF TENANTS

[Statistical Appendix, Section XI]

Philippine tenancies with their limited areas and their typical culture of rice without diversification, present labor peaks reaching the capacity of the tenants and their families during but two months of the farm year; but for the balance of the farm year—from harvest to preparation of land and to an only slightly less extent, between the preparation and the harvest—the tenants and their families are largely unoccupied with agricultural tasks. For this reason, and to supplement the income from the field, the tenant turns, wherever opportunity offers, to a secondary and non-agrarian vocation. Landlords never object to outside work on the part of tenants if it does not interfere with the regular duties of the tenant, but they usually require permission as a matter of form.

Nature of occupation and their prevalence.—Six surveys reported on secondary occupations, covering 740 tenants. Of the 740 tenants, 587 or 79 per cent were engaged in secondary occupations. Some tenants worked at more than one occupation so that the total of all occupations was 676. The most popular secondary occupation was that of general laborer of which there were 461. Fishing was a poor second with 70 men engaged. There were 50 carpenters, 38 merchants, and 35 drivers or, as they are locally known, *cocheros.*

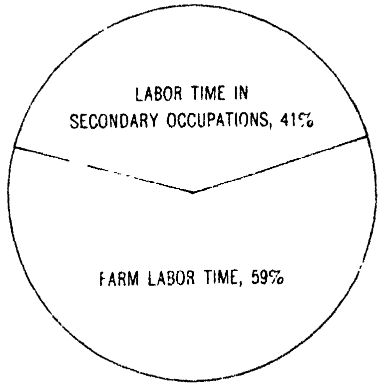

Fig. 5.—Comparison of farm and secondary labor time per hectare per annum on 740 Philippine rice tenancies.

Labor-time in secondary occupations.—The following of secondary occupations consumed more than two thirds as much time as was spent in farming, as indicated in Figure 5. The average labor time per annum for each occupation was 528 hours; for each of the 587 tenants so engaged, an average of 608 hours; for each of the 740 tenants investigated, an average of 482 hours; for each hectare, an average of 206 hours.

Income from secondary occupations.—The annual income from secondary occupations averaged ₱94 for each occupation; ₱108 for each tenant so engaged; ₱85 for each tenant of the surveys investigated; and ₱37 per hectare covered in the surveys. The proportion of the average secondary occupation income per hectare per annum to average farm income per hectare per annum was as 37 to 80 or 46 per cent.

Relation of secondary occupation to area.—The six surveys for which data on secondary occupations was collected are arranged below to show the correlation between percentage of tenants engaged and average area.

Six surveys in descending order of average areas:	*Six surveys in ascending order of percentage of tenants engaged in secondary occupations*
Santa Rosa	Hagonoy
Hagonoy	Bay
Bay	Naic
Naic	Santa Rosa
Aparri	Aparri
Calasiao	Calasiao

The agreement shown above, which is complete except for Santa Rosa, would indicate that the smaller the average area, the greater the percentage of tenants engaged in secondary occupations.

HOUSEHOLD INDUSTRIES

[Statistical Appendix, Section XII]

For reasons similar to those which lead the tenant to seek a secondary occupation, his family are wont frequently to engage in some one or more household industries. The investigation for household industries covered the same six surveys which reported on secondary occupations.

Nature and prevalence of industries.—The 740 tenants comprised 610 households. Of these households, 336 or 55 per cent were engaged in one or more home industries. The more extensive industries were embroidery in Hagonoy and hat-making in Calasiao, engaging 96 and 39 households, respectively. The manufacture of *patis*, a salted shrimp sauce, was extensive in Naic, while mat-making in Calasiao was a prominent family occupation. No investigation was attempted on the time allotted to the household industries, as they were a matter of odd moments and concerned all female members of the family, both adults and children.

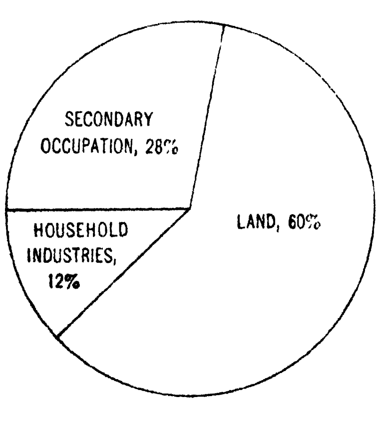

Fig. 6.—Source of tenants' average family income per hectare per annum from 740 Philippine rice tenancies.

Income from household industries.—The annual income from household industries averaged ₱77 for each household so engaged; ₱31 for each of the 740 tenants investigated; and ₱15 for each hectare covered by the reporting surveys. The proportion of the average income from household industries per hectare per annum to the average farm income per hectare per annum was 15 to 80 or about 19 per cent. As compared to the secondary occupation income the household income was approximately 40.6 per cent.

There appeared no relation between household industries and area, either considering the percentages or the average income per hectare per annum.

Family income.—Summarizing the average tenant income including family income, per annum from all sources, the result was ₱307 for each tenant; of which sum ₱189 was derived from the land; ₱87, from secondary occupations; and ₱31,

ADDENDUM

This table was inadvertently omitted in printing Vol. XII, No. 6, of THE PHILIPPINE AGRICULTURIST. It should be inserted facing page 230 of Rowan's article.

TABLE II.—*Life history of Schoenobius incertellus under laboratory conditions.*

Egg No.	Date laid.	Date hatched.	Incubation period.	First molt.	First instar.	Second molt.	Second instar	Third molt.	Third instar.	Fourth molt.	Fourth instar.	Fifth molt.	Fifth instar.	Sixth molt.	Sixth instar.	Date pupated.	Seventh instar.	Length of larval stage.	Date emerged.	Pupal stage.	Length of immature life	Date died	Adult stage	Total life history
			days		*days*		*days*		*days*		*days*		*days*		*days*		*days*	*days*		*days*	*days*		*days*	*days*
I	11-XI-22	19-XI-22	8	26-XI-22	7	3-XII-22	7	12-XII-22	9	21-XII-22	9	30-XII-22	9	12-I-23	13	22-I-23	10	64	2-II-23	11	83	5-II-23	3	86
	11-XI-22	19-XI-22	8	28-XI-22	9	7-XII-22	9	15-XII-22	8	23-XII-22	8	31-XII-22	8	12-I-23	12	21-I-23	9	63	1-II-23	11	82	5-II-23	4	86
	11-XI-22	19-XI-22	8	26-XI-22	7	4-XII-22	8	12-XII-22	8	20-XII-22	9	29-XII-22	9	10-I-23	12	21-I-23	11	64	31-I-23	10	82	4-II-23	4	86
	11-XI-22	19-XI-22	8	26-XI-22	7	4-XII-22	8	11-XII-22	7	19-XII-22	11	30-XII-22	11	11-I-23	12	20-I-23	9	65	31-I-23	11	81	4-II-23	4	88
II	13-XI-22	22-XI-22	9	28-XI-22	6	6-XII-22	8	13-XII-22	7	22-XII-22	10	1-I-23	10	13-I-23	12	24-I-23	11	64	4-II-23	11	84	10-II-23	6	90
	13-XI-22	22-XI-22	9	29-XI-22	7	7-XII-22	8	14-XII-22	7	23-XII-22	8	31-XII-22	8	12-I-23	12	22-I-23	10	60	2-II-23	11	80	8-II-23	6	86
	13-XI-22	22-XI-22	9	28-XI-22	6	7-XII-22	9	15-XII-22	8	23-XII-22	9	1-I-23	9	13-I-23	12	24-I-23	11	64	3-II-23	10	83	7-II-23	4	87
	13-XI-22	22-XI-22	9	28-XI-22	6	5-XII-22	7	13-XII-22	8	24-XII-22	9	2-I-23	9	13-I-23	11	23-I-23	10	60	3-II-23	12	81	9-II-23	6	87
III	21-XI-22	30-XI-22	9	7-XII-22	7	15-XII-22	8	23-XII-22	8	1-I-23	9	10-I-23	9	21-I-23	11	2-II-23	12	63	13-II-23	11	83	17-II-23	4	87
	21-XI-22	30-XI-22	9	8-XII-22	8	16-XII-22	8	24-XII-22	8	3-I-23	9	12-I-23	9	23-I-23	11	3-II-23	11	64	12-II-23	9	82	17-II-23	5	87
	21-XI-22	30-XI-22	9	7-XII-22	7	15-XII-22	8	23-XII-22	8	2-I-23	9	11-I-23	9	21-I-23	10	31-I-23	10	61	11-II-23	11	81	16-II-23	5	86
IV	23-XI-22	1-XII-22	8	8-XII-22	7	16-XII-22	8	24-XII-22	8	1-I-23	10	11-I-23	10	22-I-23	11	2-II-23	11	65	13-II-23	11	81	16-II-23	3	87
	23-XI-22	1-XII-22	8	8-XII-22	7	16-XII-22	8	23-XII-22	7	1-I-23	9	10-I-23	9	21-I-23	11	1-II-23	11	62	12-II-23	11	81	15-II-23	3	84
	23-XI-22	1-XII-22	8	8-XII-22	7	17-XII-22	9	25-XII-22	8	2-I-23	10	12-I-23	10	22-I-23	10	2-II-23	11	65	13-II-23	11	84	19-II-23	6	90
	23-XI-22	1-XII-22	8	8-XII-22	7	16-XII-22	8	25-XII-22	9	2-I-23	9	11-I-23	9	21-I-23	10	2-II-23	12	64	12-II-23	10	82	16-II-23	4	86
V	23-XI-22	2-XII-22	9	8-XII-22	6	16-XII-22	8	25-XII-22	9	2-I-23	9	11-I-23	9	21-I-23	10	2-II-23	12	63	13-II-23	11	83	20-II-23	7	90
	23-XI-22	2-XII-22	9	9-XII-22	7	17-XII-22	8	25-XII-22	8	2-I-23	9	11-I-23	9	22-I-23	11	3-II-23	12	64	14-II-23	11	84	19-II-23	5	89
	23-XI-22	2-XII-22	9	8-XII-22	6	16-XII-22	8	24-XII-22	8	1-I-23	9	10-I-23	9	20-I-23	10	2-II-23	13	63	13-II-23	11	83	17-II-23	4	87
	23-XI-22	2-XII-22	9	9-XII-22	7	17-XII-22	8	26-XII-22	9	4-I-23	9	13-I-23	9	23-I-23	10	4-II-23	12	64	15-II-23	11	84	19-II-23	4	88
VI	26-XI-22	4-XII-22	8	11-XII-22	7	19-XII-22	8	27-XII-22	8	5-I-23	10	15-I-23	10	25-I-23	10	4-II-23	10	63	15-II-23	11	82	20-II-23	5	87
	26-XI-22	4-XII-22	8	12-XII-22	8	21-XII-22	9	29-XII-22	8	7-I-23	9	16-I-23	9	26-I-23	10	6-II-23	11	64	17-II-23	11	83	22-II-23	5	88
	26-XI-22	4-XII-22	8	11-XII-22	7	20-XII-22	9	28-XII-22	8	7-I-23	10	17-I-23	10	27-I-23	10	6-II-23	10	64	17-II-23	11	83	21-II-23	4	87
	26-XI-22	4-XII-22	8	11-XII-22	7	20-XII-22	9	29-XII-22	9	6-I-23	11	15-I-23	9	25-I-23	10	5-II-23	11	66	16-II-23	11	85	19-II-23	3	88
	26-XI-22	4-XII-22	8	11-XII-22	7	20-XII-22	9	28-XII-22	8	5-I-23	9	15-I-23	9	24-I-23	10	4-II-23	11	63	15-II-23	11	82	19-II-23	4	86
Minimum			8		6		7		7		8		8		10		9	60		9	80		3	84
Maximum			9		9		9		9		11		11		13		13	66		12	85		7	90
Average			8 1/2		6 23/24		8 1/6		8 1/24		9 7/24		9 5/24		10 7/8		10 7/8	63 5/12		10 5/6	82 17/24		4 1/2	87 5/24

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VOLUME XII

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The Philippine Agriculturist

Volume XII June, 1923 No. 1

EDITORIAL

CAREERS

The present number of *The Philippine Agriculturist* will fall into the hands of the new students in the College of Agriculture. The introduction of first year men at the college of their choice is frequently surrounded with doubts and questions. To many a student, matriculation in college is his first experience away from home, and in the Philippines, with its barrio life which is in many ways admirable from a social standpoint, this means a great deal. Changes in vernacular, new friends, new faces, strange details confront the freshman at every step. But above all this, one great thought occupies his mind—his career. The strongest element in the make-up of a Filipino freshman is ambition and his constant goal is his career.

There are, however, a few points in regard to careers which should be emphasized and in doing so I shall address myself directly to the entering students of the College of Agriculture.

First of all, you are not to suppose that you are to become free agents, you are not to think that it is only the career of Juan or Pedro that you plan. Never! You who enter the College of Agriculture must face the fact that you are not only to make careers for yourselves but a career for your nation and a career for your race. When a nation is old and worn, when it holds the trophies of successful wars, when its furrows run from its mountain crests to its shores, when its resources are opened and expended, when its products are stabilized and its ships sail with confidence, when its institutions and its culture are fixed, and their magnitudes measured, there is left little of importance for the individual. He has become in this case a detail of a great general average—a unit, that may be disregarded, unrecognized, and over-stepped in the mechanism of the nation. In such a nation, Juan or Pedro may be lazy or extravagant or criminal, and the country may not suffer. In such a nation, a university may go to smash, or a whole class of students may fail to be graduated and there may be no perceptible faltering in the progress of the country. The career that any individual in such an environment chooses is largely his own affair and not the concern or policy of a government. But you, young men, have not been born into old things and old customs. Your generation is coincident with the birth of a nation. If you fail, if your careers shall not be successful, even a casual observer may see the damage done to your country. If this College of Agriculture does not succeed, your people will be the poorer; and the College can succeed only if its students

succeed. Think, then, not only of position and of prestige, but of service, and so plan your careers that the entire social fabric of the Philippines will have improved as a result of your having been here educated and trained.

A second point which should be emphasized whenever young men set forth to make their careers is the time element. Are you interested in yourselves in 1930 or in 1950? Are the careers that you are planning for yourselves the ones they shall be in 1930, the year after your graduation, or are you thinking of your careers of 1950, twenty years after you have graduated. Perhaps more graduates of the College of Agriculture have failed to achieve their possible measure of success through a lack of understanding of the time element than through any other cause.

You will fail if you expect merely to use the College of Agriculture as a coaching school for a given job in a given bureau at a given salary. You will never succeed if you look upon education as a fixed asset, a sort of a ticket, which once obtained, is a sure pass to a government salary and social rank. You should know that the things you will learn here are but the equipment for a much later consummation; that this equipment will be lost unless it is cherished and increased; that in any event it will not reach its full bloom until many years of experience have added wisdom to knowledge. Do not be concerned with the Juan or Pedro of 1930 but plan your careers to come to their fulfillment when you have reached the prime of life.

Let your careers be based upon activity, thrift, honesty, and courage. Remember that the progress of your race and of these, our beautiful Islands, depends upon the spirit of the fearless, forward-going pioneer, the will to do all, to face all, the restlessness that brings success, the activity—that Western spirit that long since offered itself to the Orient for emulation. The Prophet of the Pioneer was Walt Whitman and his lines are these:

> Come my tan-faced children,
> Follow well in order, get your weapons ready.
> Have you your pistols? Have you your sharp-edged axes?
> Pioneers! O Pioneers!
>
> For we can not tarry here,
> We must march my darlings, we must bear the brunt of danger.
> We the youthful sinewy races, all the rest on us depend.
> Pioneers! O Pioneers!
>
> Not for us the delectations sweet.
> Not the cushion and the slipper, not the peaceful and the studious,
> Not the riches safe and palling, not for us the tame enjoyment,
> Pioneers! O Pioneers!
>
> Do the feasters gluttonous feast?
> Do the corpulent sleepers sleep? Have they lock'd and bolted doors?
> Still be ours the diet hard, and the blanket on the ground.
> Pioneers! O Pioneers!
>
> Till with sound of trumpet;
> Far, far off the daybreak call—hark! how loud and clear I hear it wind,
> Swift! to the head of the army! swift! spring to your places,
> Pioneers! O Pioneers!

EVETT D. HESTER,
Of the Department of Rural Economics.

CORRELATION WITHIN PURE LINES OF RICE[1]

By José M. Capinpin

Of the Department of Agronomy

INTRODUCTION

One of the most striking features of rice (*Oryza sativa*, L.) is its multiplicity of varieties. These varieties differ from one another in extremely varied characters. It is on these characters, both morphological and physiological, that varietal classification in rice is based. Equally important in varietal classifying of rice, is the knowledge of correlation, or association of characters. As one authority wrote: "The great value to the breeder of definite knowledge of correlation within a species is that it gives reliable information enabling him to predict from the presence of certain characters the most probable values of associated characters".

Previous study of the correlation of characters in rice has been mostly among varieties. It may not be out of place to state in this connection that varietal correlation (correlation among varieties) may or may not give the same value as that which may be furnished by correlation within a variety. A possible case is the varietal correlation between yield and height of plant. A short variety may give as much yield as a tall one, and yet within a variety tall plants may always yield more heavily than shorter individuals. A difference, which may be either significant or insignificant, may be found in these two kinds of correlation, varietal and line. The degree of variability among varieties taken collectively is bound to be different from that among individuals within a variety and the difference is probably greatest in a pure line, If the variability of characters be taken to serve as a relative index of the coefficient of correlation, the extent of association existing between characters among rice varieties need not be the same as that in plants within a variety. Data on the correlation of characters in a pure line should be highly instructive and useful.

PAST WORK ON CORRELATION OF CHARACTERS IN RICE

The various correlation studies here surveyed are grouped into: (a) correlation within a variety, and (b) correlation among varieties.

Correlation within a variety.—Van Der Stok (1) reported that up to a certain point, thickness of the kernel appeared to be quite regularly correlated with its length, breadth, and weight. When the kernels were grouped according to length, breadth, and thickness, the grouping showed that the greatest thickness coincided with the largest average weight per kernel, while in the other two groups the result did not show a similar coincidence. From these various groupings, it was indicated that, in general, the length of the kernel stands in better correlation with its width than the average thickness does. It was also concluded that, while the observations were made on unhulled grains of pure strains of rice, the results would apply also to the hulled kernels.

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[1] Thesis presented for the degree of Master of Science from the College of Agriculture, No. 146, Experiment Station contribution, No. 116.

Peralta (2), working with pure strains of the varieties Binicol and Inintiw, found positive correlations within the variety of the following characters:

Weight of grain and weight of straw
Length of panicle and yield of grain
Days to maturity and leaf products
Yield of grain and height of plants.

Using the same varieties with which Peralta worked, Labrador (3) reported positive correlation between the breaking strength of culm and yield of grain.

From the findings of Peralta and Labrador, Mendiola (4) deduced "that length of culm and breaking strength are positively correlated".

Correlation among varieties.—Yamaguchi (5), using five varieties, studied the relation between the flowering time and the position of the flowers on the inflorescence on the one side and the seed weight of rice on the other. According to his findings there was a negative and slight correlation between the observed flowering time and the weight of the glumed or naked kernel; a positive correlation between the glume weight and the flowering time; and a "moderate" correlation between the glume weight and the weight of the naked kernel. It was further observed that the negative correlation between position and kernel weight was generally larger than that between the actual flowering time on a whole panicle and the kernel weight corresponding to this flowering time.

Hector (6), who carried out an intensive study on correlation of color characters, showed that many of the characters by which rice varieties differ are inherited in groups or patterns and not independently. A very interesting case of such gametic correlation has been proven to exist in one variety between the color in the ligule of the leaf and the color of the grain.

Mendiola (4) grouped the numerous character correlations of rice among varieties, studied by Jacobson in 1916 and by Vibar in 1921, as follows:

1. Positively Correlated:
   (*a*) Correlation, decided:
      Yield and tillering
      Yield and days to maturity
      Days to maturity and length of longest leaves
      Days to maturity and weight of straw
   (*b*) Correlation, marked:
      Yield and length of culm
      Yield and length of panicle
      Yield and number of nodes in the panicle
      Yield and length of grains
      Days to maturity and number of grains per panicle
   (*c*) Correlation, slight:
      Yield and number of spikes per panicle
      Yield and weight of leaves
      Yield and length of leaves
      Yield and weight of straw
      Days to maturity and length of culm
      Days to maturity and length of panicle
      Days to maturity and number of nodes per panicle
      Days to maturity and width of leaves
      Days to maturity and length of grains
   (*d*) Other positive correlations:
      Average number of days to maturity and average number of nodes per culm

Days to maturity and grain dimension ratio
Days to maturity and length of culm per variety
Length of culm and number of nodes per culm
Number of internodes per variety and average length of internode
Average length of culm and average length of rachis per variety
Length of rachis per variety and average number of branches per variety

II. Correlation, absent:
Yield and number of grains per panicle
Days to maturity and number of culms
Days to maturity and number of spikes per panicle
Length of grain and number of culms
Tillering and grain dimension ratio
Number of culms per plant per variety and average length of culm
Length of culm and length of grain

III. Correlation, negative:
Grain width and days to maturity
Tillering and number of grains per panicle

OBJECT OF THE PRESENT WORK

The object of this study was to determine the correlation of certain characters within pure lines of rice. It is an attempt to answer among other questions whether varietal correlation may be taken as equivalent to line correlation, and, if it may, to what extent.

TIME AND PLACE OF THE PRESENT WORK

The first part of this investigation was performed by the writer during 1920-1921. The second part, which involved strain cultures, was carried on during the rice season of 1922-1923. The different strains of the varieties used were planted in the paddies at the rear of the Administration Building of the College of Agriculture, University of the Philippines, in Los Baños, Laguna, Philippine Islands.

MATERIALS AND METHODS

The materials used in this study may be discussed under: (1) Compiled data and (2) Cultural data.

COMPILED DATA

The compiled data are based mainly on Gutierrez' (7) figures on test row cultures. In 1918, Gutierrez started the study of selection among rice varieties and the isolation of several pure lines. The variability exhibited by the test rows for every variety he studied is recorded in Table I.

TABLE I.—*Variation in uniformity of varieties used in test row cultures.*

Variety.	Percentages.		
	Uniform.	Fairly uniform	Non-uniform
Binicol	9 1	81 8	9 1
Binangbang	29 4	64 7	5 9
Ganado	5 1	56 4	38 5
Iroy	40 0	50 0	10 0
Binalayan	22 5	52 5	25 0
Diquet a Bolilising	4 0	72.0	24 0

In Gutierrez' test row results there are figures which are available for study of correlation among pure lines within rice variety and the writer used these figures in this investigation. The figures from which the coefficients of correlation were calculated, are shown in Table II (omitted).[2]

For each variety mentioned in Table II, the coefficient of correlation was determined among the following pairs of characters:

Length of culm and total number of culms
Length of culm and number of bearing culms
Length of culm and number of days from sowing to maturity
Length of culm and number of caryopses
Length of culm and weight of caryopses
Total number of culms and number of bearing culms
Total number of culms and number of days from sowing to maturity
Total number of culms and number of caryopses
Total number of culms and weight of caryopses
Number of bearing culms and number of days from sowing to maturity
Number of bearing culms and number of caryopses
Number of bearing culms and weight of caryopses
Number of days from sowing to maturity and number of caryopses
Number of days from sowing to maturity and weight of caryopses
Number of caryopses and weight of caryopses

For the computation of coefficient of correlation among these pairs of characters, correlation tables were made. There were for this purpose, alone, 90 correlation tables which are not included in this report but which are filed in the Genetics Division of the Agronomy Department of College of Agriculture.

CULTURAL DATA

It may be of interest to know the cultural history of the pure lines of rice used in this work. Gutierrez' work was continued by Romero (8), then by Cabanos (9), and then by Bernardo (10), the Division of Genetics taking direct care of the cultures. Mendiola (11) summarized this continuous rice selection work in 1919. His summary is presented in Table III

TABLE III.—*Varieties and lines originally selected by Gutierrez and the lines surviving in 1919.*

Variety name.	Number of mother plants or lines at the beginning.	Number of lines in 1919.
Ganado	39	6
Iroy	40	8
Binalayan	40	6
Diquet a Bolilising	25	6
Binicol	12	(Discontinued)
Binangbang	21	4

[2] Tables II, VI, VIII, and X are omitted because of lack of space in **The Philippine Agriculturist** These tables are on file in the Division of Genetics, College of Agriculture, where they may be consulted or copies will be furnished to any one desiring them.

As there was a shortage of paddies in the rice season of 1921-1922, the Division of Genetics cultured these strains on experimental upland plots. Because they were subjected to upland conditions, the yields were rather poor and a number of these varieties were lost. In June, 1922, only the lines and varieties shown in Table IV were available for planting.

TABLE IV.—*Varieties and lines cultured by Genetics Division that were surviving in 1922-1923.*

Variety name.	Number of lines.	Line number.
Iroy	6	0512 0514 0519 0525 0754 0518
Diquet a Bolilising	6	0703 0705 0716 0719 0731 0754
Binangbang	3	0811 0819 0844

The three varieties, with six lines each of Iroy and Diquet a Bolilising and three lines of Binangbang, were planted in paddies in this investigation. The plants were planted 30 centimeters apart with one plant to a hill on July 25, 1922. During the course of their growth, Binangbang was badly attacked by rice bugs and became undesirable for use in the study. Likewise, among the lines of the two remaining varieties, several were discarded on account of damage done by unavoidable flooding of the paddies. Because of these disasters to the three varieties, only two varieties of four lines each were used in this study. These varieties are shown in Table V.

TABLE V.—*Varieties and lines used in this study.*

Variety name.	Number of lines	Line number.
Diquet a Bolilising	4	0705 0716 0719 0754
Iroy	4	0514 0518 0519 0525

The two varieties headed at about the same time. Diquet a Bolilising was the earlier, heading on November 12, 1922, while Iroy headed on November 15. The lines within each variety did not show any difference in blooming. Both varieties matured on December 28, 1922. Harvesting was done on December 29-30, 1922, for Diquet a Bolilising, and on January 1-2, 1923, for Iroy.

Getting the data.—At maturity, 100 plants from each line of a variety were marked at random. They were then pulled up, roots cleaned, and taken to the laboratory. In the laboratory the measurement of the characters was made. A total number of 800 plants were used in this study.

The length of culm was measured from the point above the roots to the first node of the panicle. The length of panicle was measured from the last node of the culm to the tip of the panicle. The sum of the nodes in each panicle was divided by the number of panicles to find the average number of nodes to a panicle. The average number of spikes to a panicle was found by the same method. The yield per plant was the total weight of the grains (air-dried for a week) produced by a plant. The weight of the straw was the total weight of the plant (air-dried for a week) less roots and grains.

The determinations based on 100 plants of each line of a variety are shown in Table VI (omitted).

Characters used in the study of correlation from figures obtained in cultures.—In this correlation study the yield per plant was used as *subject* and the following characters as *relative:*

Total number of culms
Number of bearing culms
Length of culm
Length of panicle
Number of nodes per panicle
Number of spikes per panicle
Weight of straw

The formula of Pearson was used for the computation of the coefficients of correlation. For this purpose 56 correlation tables were constructed. These tables are filed in Genetics Division of the Agronomy Department.

EXPERIMENT AND RESULTS

This investigation reports correlation of rice characters within a variety. The association of characters was determined (1) among pure lines within the variety, and (2) within individuals of pure lines of the same variety.

AMONG PURE LINES WITHIN THE VARIETY

The data in this study are based on the test row results. The class values employed were selected elites, which are the pure lines. There were six varieties. Each variety was composed of several pure lines, the characters of which were compared. The coefficient of correlation of the fifteen pairs of characters are shown in Table VII.

This table is the summary of the 90 correlation tables, which are not included in this report. One of these 90 tables is shown in Table X-a (omitted).

WITHIN INDIVIDUALS OF A PURE LINE

The data in this correlation study were obtained from the pure line cultures. There are two varieties. Each variety is represented by four pure lines. The

correlation of characters within individuals of each pure line in a variety was determined. As was mentioned in the first part of this paper seven pairs of characters were compared. Table VIII (omitted) shows the figures, or the biometrical constants, employed in the computation of correlation coefficient.

The general formula for coefficient of correlation is $r = \frac{S\ D_1\ D_2}{N\ O_1\ O_2}$ in which r is the coefficient of correlation, S D_1 D_2 equal the summation of deviations of two characters (D_1—the *subject*, and D_2—the *relative*), N—number of individuals treated (in this case it is 100), O_1 and O_2 are the standard deviations of the *subject* and of the *relative* respectively.

The probable error of the coefficient of correlation was obtained by the formula:

$$E_r = \frac{\pm\ 0.67\ (1-r^2)}{\sqrt{N}}$$

With yield per plant as the *subject* and the other characters as the *relative*, it is not difficult to find the correlation coefficient of any pair of characters, by referring to Table VIII.

Table IX gives the coefficients of correlation of characters within pure lines of each variety cultured. This is the summary of 56 correlation tables constructed for the purpose. The figures, or the coefficients of correlation, in this table may be checked by referring to Table VIII. Table X-b (omitted) is a sample of the 56 correlation tables made.

DISCUSSION OF RESULTS

In discussing the different coefficient values found in this work the following rules of King (12) for the interpretation of the coefficient of correlation according to its relation to the probable error were taken as a guide:

1. If r is less than the probable error, there is no evidence whatever of correlation
2. If r is more than six times the size of the probable error, the existence of correlation is a practical certainty.
3. In cases where the probable error is relatively small:
   (*a*) If r is less than 0.3 the correlation cannot be considered at all marked.
   (*b*) If r is above 0.5 there is decided correlation.

CORRELATION AMONG PURE LINES WITHIN THE VARIETY

The coefficient values of certain pairs of characters of the pure lines within the variety are slightly variable. These values may be found in Table VII. The variability in the figures may be attributed to the fact that the materials used in each case were selected elites which, of course, are not much affected by law of chance when treated biometrically. However, these results would give us information as to the extent of association of characters among pure lines within the variety and among elites in particular.

Applying King's standards, it will be seen in Table VII that the correlation between length of culm and total number of culms, length of culm and number of bearing culms, length of culm and number of days from sowing to maturity, length of culm and number of caryopses, length of culm and weight of caryopses, total number of culms and number of days from sowing to maturity, number of bearing culms and number of days from sowing to maturity are either slightly negative or slightly positive, but no one of these values is significant. Marked

and positive correlation was found between total number of culms and number of bearing culms, total number of culms and number of caryopses, total number of culms and weight of caryopses, number of bearing culms and number of caryopses, number of bearing culms and weight of caryopses, and number of caryopses and weight of caryopses. The correlation between number of days from sowing to maturity and number and weight of caryopses is not clearly enough established that a definite statement can be made by the writer. While some varieties show evidence of correlation between this pair of characters, others give insignificant value.

Among pure lines of a given variety, there were some correlation coefficients which agree with those obtained from among varieties, and there were others which do not. Jacobson (13) said that among varieties the height of the plant has a noteworthy effect on the yield, in this work, however, it was found that among pure lines, culm length and weight of caryopses were not so associated as to be a practical guide in selection, that is, the association was not decided. Also, among varieties, Jacobson found that there exists a negative correlation between number of grains per panicle and tillering. In this study the writer found that among pure lines in a variety the total number of culms and number of caryopses were positively and decidedly associated.

CORRELATION WITHIN PURE LINES IN THE VARIETY

The materials used in this kind of correlation, besides being plants of one variety, are in a state of pure line. Relationship of plant characters based on this class of materials is, therefore, more reliable than that shown among pure lines within the variety.

By referring to Table IX it will be noted that the two varieties, and even the pure lines represented in each variety, exhibit variable coefficient figures for certain pairs of characters compared, although the same values in other pairs of characters run parallel.

In this study, there were found decided and positive correlations between yield and total number of culms, yield and number of bearing culms, and yield and weight of straw. There were slight correlations between yield and length of panicle, yield and number of nodes per panicle, and yield and number of spikes per panicle. On the other hand, the coefficient was very low and showed no evidence of correlation in the case of yield and length of culm.

An outstanding feature which was brought out from this correlation study, is the difference observed between the coefficients of varietal correlation (correlation among varieties) and line correlation (correlation among plants of one variety, or among individuals in the same pure line). Jacobson (13) and Vibar (14), working among several varieties, reported a marked correlation between length of culm and yield. According to their findings, tallness serves as a good index in selecting high yielders when running variety tests. In the writer's work, the coefficient of correlation applied to plants of a single variety, between length of culm and yield, was found to be slight and insignificant. In test row cultures, especially in the head-to-row experiments, tall plants are not necessarily good yielders. Peralta (2) gives a high correlation coefficient between height of plants and yield, the value approaching a perfect correlation. It must be borne in mind, however, that in Peralta's work, "the figure for height is the average height of all the culms produced in the representative plants and the yield is

the harvest". Peralta claimed that the coefficient referred to a single variety, which, he said, was supposed to be a pure strain. The difference between the coefficients reported in this work and that of Peralta may be explained on the ground that he used a smaller number of plants and a variety different from that used in the present investigation.

The correlation between yield and length of panicle was marked among varieties. Vibar reported 0.4704 $\pm$0.0566 as the coefficient of correlation of this pair of characters. Within individuals of pure line, the coefficient is rather slight, not even more than 0.3. This illustrates that within plants of a pure strain, panicle length is not of much practical utility as a sign of a good yielding plant.

A condition similar to yield and length of culm is met with in the case of yield and number of nodes to the panicle. The present study obtained a coefficient less than 0.2, while Vibar found it to be more than 0.4 among varieties. This he considered a marked correlation. In the present work, the number of nodes to the panicle, among plants of the same line or of the same variety, has no practical value as a guide in selection, as is true of the coefficient among varieties.

The yield per plant is highly correlated with weight of straw among plants of a pure line. This pair of characters, however, is found to be slightly associated when applied among varieties.

It is to be regretted that the characters which have been studied among varieties were not all dealt with in the study of correlation within pure lines. However, it may be said that of the characters so far studied there are some which, while correlated among varieties, are not always correlated within pure lines.

CONCLUSIONS

From the results obtained in the study of correlations among pure lines within a variety and among individuals of pure lines in the same variety, the following conclusions may be drawn:

1. Among plants of a pure strain, or those in a state of pure line, culm length may not be taken as an index of a high yielding plant. Correlation among varieties showed that this pair of characters is highly and positively associated.

2. Tillering, number of bearing culms, and weight of straw are decidedly associated with yield. In varietal correlation, weight of straw is slightly correlated with yield.

3. Length of panicle, number of nodes per panicle, and number of spikes per panicle, are slightly associated with yield.

4. The pure lines in a given variety do not show significant figures as to the association of yield and days to maturity.

Some of the figures found in the present correlation study substantiate those obtained in varietal correlation, while others are not in agreement. This gives some information as to what may be expected among varieties and among plants within a variety. The importance of these relationships is realized in rice selection work. When running variety tests, varietal correlation coefficient may be taken as a guide. In pedigree cultures, where isolation of better strains, or pure lines, is the aim, the line correlation coefficient may be used, instead.

ACKNOWLEDGMENT

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TABLE VII.—*Showing the coefficients of correlation among pure lines of different varieties of rice.* [a]

Characters compared.	Varieties.					
	Binicol 5891 F_1	Binangbang 5892 F_1	Ganado 5893 F_1	Iroy 5894 F_1	Binalayan 5895 F_1	Diquet a Boli-lising 5896 F_1
Length of culm and total number of culms.	−0 140±0 162	−0 136±0 137	−0 190±0 130	−0 209±0 07	−0 054±0 150	−0.130±0 150
Length of culm and number of bearing culms	−0 370±0 160	−0 120±0 117	−0 180±0 134	−0 358±0 134	−0 117±0 141	−0.013±0 135
Length of culm and number of days to maturity.	−0 199±0 179	−0 235±0 150	−0 067±0 147	−0 306±0 114	−0.127±0 126	−0 400±0 130
Length of culm and number of caryopses	0 070±0 010	0 056±0 121	0 143±0 052	0 150±0 126	0 220±0 152	0.126±0 015
Length of culm and weight of caryopses	0 220±0 192	0 000±0 120	0 051±0 126	0 113±0 117	0 042±0 126	0 095±0 128
Total number of culm and number of bearing culms	0 936±0 044	0 980±0 051	0 830±0 058	0 690±0 075	0.900±0 037	0 840±0.048
Total number of culms and number of days to maturity.	0 260±0 102	0 480±0 033	0 230±0 110	0 080±0 090	0 070±0 016	0 374±0 130
Total number of culms and number of caryopses	0 792±0 083	0 725±0 861	0 770±0 069	0 456±0 102	0 590±0 091	0 794±0 010
Total number of culms and weight of caryopses	0 910±0 036	0 730±0 054	0 760±0 058	0 300±0 090	0 550±0 096	0 620±0 093
Number of bearing culms and number of days to maturity	0 320±0 169	0 000±0 130	0 230±0 061	0 012±0 108	0 120±0 137	0 096±0 148
Number of bearing culms and number of caryopses	0 810±0 071	0 790±0 048	0 720±0 067	0 630±0 072	0 610±0 066	0 870±0 058
Number of bearing culms and weight of caryopses	0 410±0 166	0 750±0 053	0 770±0 048	0 570±0 080	0 540±0 098	0 600±0 089
Number of days to maturity and number of caryopses	0 550±0 076	0 410±0 116	0 310±0 117	0 330±0 106	0 030±0 128	0 022±0.148
Number of days to maturity and weight of caryopses	0 160±0 194	0 420±0 107	0 360±0 121	0 230±0 056	0 150±0 135	0 120±0 147
Number of caryopses and weight of caryopses	0 610±0 013	0 907±0 025	0 930±0 018	0 850±0 033	0 740±0 053	0 940±0.019

[a] Summary of 90 correlation tables which are not included in this report, but which are filed in the Genetics Division of the Agronomy Department, College of Agriculture, Los Baños, P. I.

TABLE IX-a.—*Showing the coefficient of correlation within pure lines of rice.*

Variety: Iroy 5894 F_7 [a]

Characters compared.	Pure Line 0514	Pure Line 0518	Pure Line 0519	Pure Line 0525
Yield and total number of culms	0 562±0 0455	0 300±0 0614	0 620±0 0435	0 548±0 0402
Yield and number of bearing culms	0 648±0 0391	0 622±0 0410	0 706±0.0345	0.598±0 0432
Yield and length of culm	0 092±0 0664	0 130±0 0656	0.049±0 0660	0 093±0.0663
Yield and length of panicle	0 185±0 0666	0 199±0 0643	0 164±0 0638	0.192±0.0645
Yield and number of nodes per panicle	0 180±0 0648	0 056±0 0663	0 112±0.0658	0 107±0 0569
Yield and number of spikes per panicle	0 321±0 0600	0 250±0 0623	0 132±0 0648	0 354±0.0582
Yield and weight of straw	0.630±0 0432	0 507±0 0497	0 790±0 0242	0 539±0 0475

a Summary of 28 correlation tables, which are not included in this report, but which are filed in Genetics Division, Agronomy Department.

TABLE IX-b.—*Showing the coefficient of correlation within pure lines of rice.*

Variety: Diquet á Bolilising 5896 F_7 [a]

Characters compared.	Pure Line 0705	Pure Line 0716	Pure Line 0719	Pure Line 0754
Yield and total number of culms	0 373±0 0576	0 517±0 0490	0 762±0 0287	0 548±0.0201
Yield and number of bearing culms	0 571±0 0448	0 621±0 0351	0 771±0.0271	0.555±0.0462
Yield and length of culm	0 170±0 0649	0.126±0 0656	0 107±0 0665	0 197±0.0626
Yield and length of panicle	0 192±0 0643	0 262±0 0622	0 271±0.0620	0 250±0.0623
Yield and number of nodes per panicle	0 055±0 0668	0 071±0 0665	0 110±0 0661	0 059±0.0663
Yield and number of spikes per panicle	0 186±0 0439	0 224±0 0629	0 159±0 0633	0 271±0 0620
Yield and weight of straw	0 434±0 0542	0 681±0 0391	0 770±0 0272	0 315±0 0603

a Summary of 28 correlation tables, which are not included in this report, but which are filed in Genetics Division, Agronomy Department.

THE SMUDGING OF MANGO TREES AND ITS EFFECTS[1]

By Leon G. Gonzalez

With a prefatory note by Professor J. Edgar Higgins

PREFATORY NOTE

The tillers of the soil in every land have their own practices, which, so far as their knowledge is concerned, rest wholly upon an empirical basis. Many such practices extend far back into the dim past and their origin can not now be determined. In the Philippines the custom of smoking, smudging, or heating mango trees has grown up and for the avowed purpose of causing the trees to flower and hence to produce fruit. This practice, so far as available records indicate, appears to be peculiar to this region. Its origin is not known but it is probable that after a camp fire or the burning of rubbish under a mango tree, flowers were seen on the tree which led, in time, to the trial of such fires for the specific purpose of forcing flowering. The use of smudging and heating of orchards as a protection against cold weather is, of course, widespread in modern horticultural practice but in such cases there is no desire to cause flowering and no claim that such is the result. In fact, if such were the result of smudging as practiced by commercial orchardists in frost-threatened regions, the whole purpose would be defeated. But the Filipino mango grower lights the fires under his trees for the express purpose of bringing about flowering and in so doing his custom seems to be unique although it is possible that it may be found among other related peoples in this general region of the tropics.

It is one of the functions of the technical agricultural investigator to test such practices and to determine whether beneath their empirical foundation there lies a basis of fact and whether the results have been correctly interpreted and the desired ends may be attained by the performances that are current among the cultivators. No records have been found of any scientific experiments in the smudging or heating of mango trees and the observation of the effects in relation to flowering and fruiting.

It is a well-known fact that certain sucking insects of the order Jassidae (chiefly species of *Idiocerus*) infest the mango trees in vast numbers, causing great injury to the flowers and completely inhibiting fruit production in some cases. Smoking the trees naturally drives these insects away and possibly kills many of them, especially when sulphur is added to the fire as is frequently done by the smudgers. Some observers have concluded that the entire value of smudging lies in its effects as an insecticide and an insect-repellant. On the other hand there has always been a persistent belief among the mango growers that their fires were efficacious in other ways as well as in insect control. In short, they have always been firmly convinced that their fires produce flowering at seasons when the mango tree does not normally flower, whether insects be present or not.

It has long been known that heat will cause dormant flower buds to open in midwinter. The demonstration frequently has been made in midwinter by con-

[1] Thesis presented for graduation from the College of Agriculture, No. 147, Experiment Station contribution, No. 117.

ducting a small part of a branch of a dormant tree through an opening in the wall of a warm room or a greenhouse and there the flower buds open as though spring had arrived but outside zero temperature holds the rest of the tree in a perfectly dormant state. Heat apparently is the only important variant factor in the conditions between absolutely dormant buds and those that come into full bloom. This suggests a possible analogous effect upon mango trees of the increased heat produced by smudging. It must also be remembered that the months when the process is carried on are those of slightly lowered atmospheric temperatures. What the effect of increased heat may be upon the formation of flower buds is a further question.

My student, Leon G. Gonzalez, who was at the time a candidate for the degree of Bachelor of Science in Agriculture in the University of the Philippines, undertook a study of some of these problems as a thesis investigation. His objects were first to make observation of the effects, if any in flowering, attributable to the building of fires of different degrees of intensity under the mango trees; second to note the relation of these fires to the control of mango hoppers; and finally to note any apparent relation between such insect control and the opening of the flower buds. The accompanying paper records his method of attack and his observation. The report of the investigation constitutes a valuable contribution to horticultural literature along an unusual line of research.

INTRODUCTION

The mango tree (*Mangifera indica* Linn.) tends to produce a crop only once in two or three years and in some cases at longer intervals. If an effective means of forcing the tree to flower could be employed, the production of mango fruit could be very materially increased and this delicious fruit be supplied at times of the year other than the regular fruiting season. The selection and propagation of good yearly-bearing trees might bring about the condition of regular harvest, but this method would take time, as the mango tree requires a number of years before it comes into bearing.

There are several methods that have been tried by horticulturists for forcing the bearing of mango trees. The Porto Rico Agricultural Experiment Station (1) has employed several means to make the tree flower. Girding the branches, branch pruning, and the cutting of secondary roots have been practiced with some degree of success. In India, root pruning has been practiced to some extent and also the application of common salt to the soil. No claim, however, has been made that any of these practices have any influence in causing the tree to flower in any other than its normal season.

Smudging, a practice found in the provinces of Bulacan and Cavite in the Philippine Islands is believed by the growers in those regions to be effective in bringing about such results. Some observers are of the opinion that the result is not due to forcing, but to the control, by the smudging, of certain sucking insects. These insects are several species of Jassidae (Mango hoppers). The writer has not been able to find any record of exact experiment confirming or, otherwise, either of the two contentions.

The primary objects of the present work were to study the effect of the smudging upon the trees, the relation of such smudging to insect control and the further

relation of such control to the opening of the flower buds and the production of fruit. The secondary object of investigation was to determine the most suitable time for smudging to bring about the desired results.

The investigations were conducted in Bulacan where conditions are favorable and materials plentiful.

THE SMUDGING

MAKING THE SMUDGE

The fire used by mango growers for smudging is made of a conical pile of light combustible materials, with moist or green fuel on the top when it is desired that the heat be reduced. The size of the pile varies from half a meter to two meters in diameter, depending on the intended purpose. If it is to be used for forcing, the size is much larger than if used only to drive away insects that may be feeding on the leaves or flower buds. The size of the pile is also determined by the size and height of the tree. The taller the tree, the larger the pile, so that the smudge produced will readily reach the crown. The number of fires depends on the size of the tree. While a single fire usually produces enough smudge, still there are times when two or even three fires are needed; as when the direction of the wind changes, thus blowing the smoke in several directions, or when the volume produced is not sufficient to reach the whole crown. The fires are commonly built on the ground beneath the tree, a few meters from the main trunk. Wind-breaks of straw mats, *sawali*, or banana leaves held together by means of bamboo frames, and other similar protective materials are put around the fire. These wind-breaks check the strong currents of air and force the smoke up into the tree. Sometimes the fires are built on platforms put under the tree. The platform which rests on four bamboo posts is made of woven bamboo slats with a piece of galvanized iron or a layer of soil a few decimeters thick on top to prevent the bamboo from burning. The top part of the platform is at the center of the crown, the purpose being to place the smudge where it is most desired.

In some places in the province of Cavite a smokestack is used. This is a cone-shaped enclosure with a chimney at the top. The enclosure has an opening on the side and the whole serves as a fireplace. It is made of pieces of wood, generally green branches, held together by a frame of bamboo slats. To protect it from burning it is plastered with a thick mixture of mud held together with rice straw. The dimensions of the enclosure vary, but are never more than two meters in diameter at the base and three meters in height. At the top of this enclosure is a tall cylindrical chimney made of thin strips of bamboo woven together. The height of the chimney is generally adjusted so that the free end will reach that part of the crown where branches and leaves are most dense. Fire is built in the fireplace and the process which is described later is carried on.

Materials for smudging are easy to gather. Any cheap combustible material is believed to be well suited for the purpose. However, the material most easily obtainable, such as dried leaves, twigs, and stumps of bamboo, rice straw, branches of trees of not much value, and dried green grass are usually used. These materials are gathered a few days before smudging and kept under the tree or a shelter to keep them dry. After the smudging has been started, a man gathers fuel every day to keep the smudge burning. One man usually does all the work in smudging, with the help sometimes of members of the family or near

relatives. Paying labor to gather these materials is practiced only to a very limited extent.

PROCESS

The process of smudging is quite simple. It is a universal practice among smudgers to make the first smudge big and hot. In most cases a rather hot fire instead of a smudge is built. Sometimes the heat of the fire wilts some of the leaves of the tree causing them to fall off after a few days. The fire is kept burning for twelve hours and then green grass and small branches or bamboo stumps are put on it to produce smoke. This smudge is kept burning day and night if quick results are desired. Sometimes smudging is done at about ten in the morning and stopped in the evening. In this case the tree is not smoked if the leaves are wet either with rain or dew as it is believed that if this is done the leaves will become black and the tree will not produce flowers. Smudging is stopped after the flower cluster buds begin to burst, and before any flowers have opened. Also, if no result is obtained after twenty days of continuous smudging or sixty days of intermittent smudging as described above, the effort to force flowering ceases and the fires are allowed to die out.

SELECTING THE TREE

It is generally believed that success in bringing the tree to flower by smudging depends largely on the tree's being at the proper stage. Experience plays an important part in determining whether the tree is in proper condition for smudging. It is difficult to describe the appearance of a tree that is considered in the right condition so that the novice could judge by points given. An experienced smudger recognizes a tree as ready for smudging if it has an appearance of suspended growth, that is, advanced maturity of leaves and latest flush. The leaves are dull green and in some cases greenish brown or almost copper-colored. The copper-colored leaf stage is considered the best. The brittleness of the leaves when crushed in the hand is also an indication of advanced maturity; flexibility of the leaves suggests immaturity. The terminal buds should be dormant, but well formed. The smudgers sometimes examine these with the finger to determine whether the buds are good.

Trees, the leaves of which are not quite matured, are sometimes smudged for the purpose of hastening their maturity. In this case the smudging is not done regularly.

TIME

The best time of the year for smudging is said to be the latter part of October, the whole of November and the earlier part of December. Sometimes the smudging period is extended to the earlier part of January, but this is considered by many as not profitable since there are unsmudged trees coming into flower about February and the price for fruit may not be enough to justify the extra expense for smudging.

A settled condition of clear weather is a very important factor in smudging as the susceptibility of the flowers and fruit to disease is greater in rainy weather. During the months named as the proper time for smudging, bright weather usually occurs at intervals of about two or three weeks. The smokers do the work when they believe the weather will be good. There is a popular belief that one

week before the appearance of a new moon is the best time to begin smudging, as fewer rainy days are expected when there is a moon. The permanency of the direction of the wind and its strength are also taken into account. It is best if the wind blows from one direction, only, so that the smoke can easily be directed. High winds are undesirable.

When the flower clusters have opened to a length of about two centimeters, smudging is stopped. If, upon the opening of the buds harmful insects feed on them, smudging is again begun. This smudging is slow and not continuous or hot. Insects, usually, are troublesome when the flowers give out a strong aromatic odor. This period lasts, approximately, from three to nine days. After the odor ceases to be strong, insects are said to leave the tree and the smudge can be stopped. Smudging may be necessary when the fruit is about the size of a seed of mungo (*Phaseolus mungo* Linn.) if the trees are attacked by mango hoppers. One or two hours a day if the insects are plentiful and once or twice a week if they are not is all that is necessary. Smudging at this time is done only to drive away the insects and the abundance of these determines how much is necessary. Some smudgers use a little sulphur in the fire when the work is being done to eliminate insect pests.

EXPERIMENTS AND RESULTS

INCREASE IN TEMPERATURE IN DIFFERENT PARTS OF THE TREE

To secure data on the relative increase in temperature in different parts of the tree during the smudging process the following experiments were made:

Four mango trees under apparently similar conditions were used. They were designated as Tree I, Tree II, Tree III, and Tree IV.

Tree I was used as a check to the other three. It was not given any treatment.

Tree II was smudged, the rise in temperature being 1.05°C to 1.87°C. This represents trees smudged with "low" fire. Results from this kind of smudging were seen after a period of from thirty to fifty days at which time flowers began to appear.

Tree III was smudged with "medium" fire. The rise in temperature varied from 2.00°C to 4.15°C. With this kind of smudging, flower clusters were obtained after from fourteen to twenty days.

Tree IV was treated with a still warmer fire. The rise in temperature was from 4.4°C to 8.00°C. Results in flower clusters were obtained after from seven to twelve days.

Thermometers were hung in the different parts of each of the four trees and the temperature taken at intervals of one hour. Readings were made from six in the morning to six in the evening.

The record of temperature changes in the different parts of the tree and under different heat of smudge is given in Tables I, II, and III. The letters and figures used to indicate the locations of the thermometers are here explained.

M. T_2—Main trunk of the tree, two meters above the ground.

M. T_3—Main trunk, three meters above the ground.

M. T_5—Main trunk, five meters above the ground.

T. C.—Top of the crown, seven meters above the ground.

S_3 B_3—Side branch, three meters from the main trunk and three meters above the ground.

S_3 B_5—Side branch, three meters from the main trunk and five meters above the ground.

E. S. B.—End of side branch, six meters from the trunk and five meters above the ground.

T. O. C.—Temperature of the control tree.

The temperature in the different parts of the tree used as a check was found to be practically the same at all readings, two tenths of a degree being the greatest variation.

Tables I to III exhibit the records of temperature at all the points mentioned, except in the case of the control tree. The reading at one point only, that is at main trunk two meters above the ground, is recorded for this tree because, as stated, the temperature was practically the same throughout the tree.

RELATION OF RISE IN TEMPERATURE TO THE FORMATION OF FLOWER BUDS

To find the relation of the rise in temperature to the formation of flower buds, observations were made on trees being smudged by men who make this a business. The heat of the smudge in each case was determined by taking the temperature at two meters above the ground on the main trunk, that is, corresponding to M. T_2. The tendency of the smoke is to go upward and distribute itself fairly evenly among the different branches. The date when the smudging of each tree was begun, together with the date when results were obtained, was recorded. Each tree as to insect attacks, maturity of leaves, and terminal buds was closely examined and findings recorded. In the description of the maturity of the leaves, "mature" indicates that the leaves were well-matured, being very brittle and dull grayish green to copper-color. The buds were dormant, but filled and plump. "Flushed" indicates that the leaves were new, shortly after a new growth or flush. The terminal buds were small and loose. The leaves were light bright green in color and very pliable. The stage between "flushed" and "matured" is termed "immature". As the term suggests, the leaves were not well matured. The color was dark green. The terminal buds were forming, but not full and plump.

The observations are presented in Table IV.

FORCED FLOWERING

A second set of experiments was run to find out whether or not mango trees can be made to flower at any time of the year. In the Philippines, the mango is known to flower normally between February and the latter part of April. The plan in this set of experiments was to smudge every month from June to January. These months cover that part of the year when flowering does not normally occur.

Each of the sets of smudging are designated by a name corresponding to the month in which the smudging was done, as June Set, July Set, etc. In each case, conditions, as uniform as possible, were selected. Three trees were used in each set. One was for a check, and the other two were smudged. All trees used were in condition indicated as "mature". The records of the results are given in Table V.

EFFECTS OF SMUDGING ON MANGO HOPPERS

To find the effect of smudging on mango hoppers and the further relation of this insect to the flowering of the. Mango tree and formation of fruit, the following experiment was conducted.

Four trees of apparently the same condition and all infested with mango hoppers were selected. One of the trees was used for a check while the others were smudged. At all times the fires were kept very low. This was done by putting green grass or sometimes pieces of sheet iron on the top of the fire to keep it down, so only smoke was produced. The smudging was begun December 23. During the process of smudging the trees were examined daily. After one day of smudging most of the hoppers were gone from the three smudged trees while in the check they seemed to have increased in number. After the third day, only a few hoppers could be seen in the smoked trees while in the check the number continued undisturbed. After the fifth day of smudging no hopper could be found in the smoked trees.

The process was continued until January 23. During this entire period no hopper was found in the three smudged trees while in the untreated tree they remained undisturbed. The insects came back to the smudged trees three days after smudging was stopped. None of the trees flowered. The average increase of temperature was 2°C.

The second set of experiments was begun December 26. The average change in temperature was 1.87°C. The same results were obtained as in the first set. Smudging was stopped January 24.

PROPER STAGE OF THE TREE FOR SMUDGING

Cases are known when smudging, though properly done, fails to make the tree flower. It was one of the objects of this experiment to find out if there is a condition of the tree when it responds best to smudging. Six trees were selected, two at the "mature" stage, two at the "immature," and two at "flushed". The two trees at each stage were similar and were subjected to the same conditions.

One tree at each stage was used as a check while the other was smudged. The fires built were similar in size and heat. After twelve days the "mature" smudged tree flowered quite abundantly. The "immature" tree flowered sparsely after thirty-five days. The "flushed" had not flowered at the end of sixty days. The terminal buds of this tree were examined and found to be just as when smudging was first begun. The leaves, however, were more mature than those of the check. The checks for the "mature" and "immature" did not show any appreciable change.

The experiment was run a second time, following the same procedure. The "mature" tree flowered after thirteen days. The check for this remained in the same condition as at the beginning of the experiment. The "immature" tree flowered after thirty-seven days. The check remained unchanged. The "flushed" tree had not flowered at the end of sixty days, but, again, the leaves were more mature than the check.

DISCUSSION OF RESULTS

Table IV shows that in every case, except Tree 14, flowering followed the smudging, while none of the untreated trees flowered. Tree 14 came into a new

flush. This shows that in every case there was a marked effect either in the form of flowering or a rapid increase in the rate of growth, due to smudging. It was also demonstrated that under the same condition the higher the rise in temperature the sooner the trees flowered. It was observed that during the process of smudging any degree of heat of fire can be used so long as the leaves are not burned.

The relation between the rise in temperature and the amount of flowers produced is not fully shown by the records, because only two degrees of flowering were indicated; namely "abundant" and "sparse". But observations showed that the higher the temperature, the more abundant the flowering.

From the results of this experiment it may be deduced that the flowering is due to the heat of the smudge. This is supported by the fact that the increase in temperature was directly proportional to the amount of flowers produced and varied inversely with the time required to produce flowering. Records of the experiments also show that the flowering following smudging from August to January was not due to the elimination of the insects, because these were eliminated in some experiments by light smudging but still the trees did not flower. The same experiments showed that smoke, alone, did not bring about flowering but drove out the insects.

Twigs of mango trees of the degree of maturity considered suitable for smudging were submitted to Professor F. P. McWhorter of the Department of Botany who kindly made a micro-chemical examination of the material. Twigs were also submitted from trees that had been smudged four, seven, and nine days respectively. The following very interesting memorandum on the subject by Professor McWhorter is presented:

> The dormant stem tips of the mango contain, just beneath the buds, a rather specialized storage region. In this region during the maturing of the buds the plant normally deposits a food store and a supply of enzymes for the carrying out of the metabolic processes involved in the translocation and assimilation of the food store. In such fruits as have been investigated, for example, plum, pear, etc., it is known that flowering takes place when the food supply of the stem tip has been rendered immediately available for assimilation through action of enzymes. Branches of many temperate fruits when cut in midwinter and brought into a warmer room will soon bloom. This response is due to temperature. Why a change in temperature produces such quick response is evident when we remember that many enzyme reactions are not doubled in rate every 10° change but increase five or six times. So the early flowering of mangoes after smudging may be explained as response to the constant and continued rise in temperature. The smoke probably has no stimulative effect whatever on the mangoes or their time of flowering.

It may be of importance to note that several trees were known to have flowered three or four times successively at intervals of from two to three weeks. These trees flowered from smudging, but the flowers were destroyed either by fungus or insects.

Table V shows that, except for the rainy months of June and July, the mango tree can be made to flower by smudging any time of the year. Even in the months excluded, if a fire could be kept burning, it is highly probable that flowering could be effected. However, it is impracticable to smudge during these months or at any time when the weather is not settled for the flowers would be destroyed by fungus. The records show that flowering during the month of August was

sparse. This was probably due to the fact that the fire was often put out because of rain and hence the temperature was often lowered. The same was true in the month of September.

There is no doubt that mango fruit offered in the market at an earlier season than the regular crops come on commands a maximum price. Nevertheless, it is not advisable to smudge if the weather is not settled. In this experiment it was safe to smudge beginning with the month of October, 1921, but this can not be established as a rule for every year. For increase of returns, it is not advisable to smudge during the months later than January as there are trees beginning to flower normally at this time and the difference in the price of the fruit is not enough, usually, to cover the expenses incurred in the process of smudging. There are trees that do not bear flowers every year and trees not flowering as late as the month of April are not likely to flower until the next year. In such cases it might pay to smudge the trees early in May so that the setting of the fruit would be over before the beginning of the rainy season. The experiments recorded in this paper show that the more mature the leaves of the mango tree the quicker it responds to smudging This accounts for the fact that some trees, although smudged properly, fail to give the desired results or they flower after a much longer period than is expected. Trees with leaves not well-matured may have been selected in this case so a longer time was necessary before results were obtained.

SUMMARY AND CONCLUSIONS

1. The mango tree can be made to flower by means of smudging at any time of the year, provided that the tree is in condition for forcing.

2. It is the heat and not the smoke that causes flowering.

3. The amount of flowers produced is directly proportional to the increase in temperature within the limits of safety from burning the leaves.

4. If smudges of less intensity of heat are used, the length of time of smudging should be proportionately increased before flowers will appear and under such circumstances the flowering is likely to be less abundant.

5. Smoke drives away the insects but they return immediately after smudging is stopped.

6. The best time for smudging lies between the months of October and December, depending on weather conditions. Smudging should be done when the weather seems to be settled.

7. The best condition of the tree for smudging is when the leaves are well-matured and the terminal buds dormant and well formed.

ACKNOWLEDGMENT

The writer is greatly indebted to Prof. J. E. Higgins, Head of the Department of Agronomy, under whose guidance this work was prepared, and to Associate Professor Frank P. McWhorter of the Department of Botany for his microchemical studies of buds.

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TABLE I.—*Temperature changes with low fire.*

Time.	T.O.C.	M. T_2	M. T_3	M. T_5	T. C.	S_3 B_3	S_3 B_6	E.S.B.
	°C	°C	°C	°C	°C	°C	°C	°C
6:00 a. m.	25.00	26.50	26.50	26.50	26.50	25.50	26.00	25.90
7:00	25.00	26.60	26.50	26.50	26.50	26.50	26.10	26.00
8:00	25.30	27.10	27.00	27.00	27.00	27.00	26.50	26.50
9:00	25.40	27.10	27.00	27.00	27.00	27.00	26.50	26.50
10:00	25.50	27.30	27.20	27.20	27.00	27.00	26.50	26.50
11:00	26.00	28.00	28.00	28.00	27.50	27.70	27.50	27.50
12:00	26.30	28.20	28.10	28.10	27.90	28.00	27.80	27.70
1:00 p. m.	26.50	28.50	28.50	28.50	28.00	27.00	27.00	28.00
2:00	26.50	28.50	28.50	28.50	28.00	27.50	27.50	27.50
3:00	26.70	28.50	28.50	28.50	27.60	27.50	27.70	27.50
4:00	26.50	28.50	28.50	28.50	27.50	27.50	27.50	27.40
5:00	26.00	28.20	28.20	28.10	27.00	27.20	27.00	27.00
6:00	25.80	28.00	27.90	27.80	27.00	27.00	27.00	27.00
Average rise in temp. .		1.87	1.84	1.81	1.30	1.22	1.12	1.08

TABLE II.—*Temperature changes with medium fire.*

Time.	T.O.C.	M. T_2	M. T_3	M. T_5	T. C.	S_3 B_3	S_3 B_5	E.S.B.
	°C	°C	°C	°C	°C	°C	°C	°C
6:00 a. m.	25.00	29.20	29.20	28.70	28.50	28.60	28.70	27.50
7:00	25.00	29.30	28.80	28.60	28.20	28.40	28.00	27.70
8:00	25.30	29.50	29.20	29.00	28.60	28.70	28.40	28.10
9:00	25.40	29.60	29.50	29.10	28.90	28.90	28.50	28.20
10:00	25.50	29.60	29.40	29.15	28.70	28.90	28.30	28.00
11:00	26.00	30.10	29.70	29.50	29.00	29.10	28.70	28.30
12:00	26.30	30.50	29.90	29.70	29.10	29.40	28.70	28.40
1:00 p. m.	26.50	30.60	30.20	29.70	29.30	29.50	28.90	28.50
2:00	26.50	30.50	30.10	29.80	29.20	29.40	28.80	28.50
3:00	26.70	30.65	30.15	29.85	29.30	29.50	28.90	28.50
4:00	26.50	30.40	30.10	29.70	29.00	29.30	28.50	28.20
5:00	26.00	30.05	29.70	29.30	29.00	29.00	28.60	28.25
6:00	25.80	30.00	29.60	29.30	28.50	28.70	28.30	28.10
Average rise in temp....		4.11	3.74	3.48	3.00	3.13	2.60	2.35

TABLE III.—*Temperature changes with warmest fire.*

Time.	T.O.C.	M. T_2	M. T_3	M. T_5	T. C.	S_3 B_3	S_3 B_5	E.S.B.
	°C	°C	°C	°C	°C	°C	°C	°C
6:00 a. m.	25.00	33.00	32.50	31.50	31.00	31.40	30.60	30.00
7:00	25.00	33.10	32.50	31.60	31.10	31.50	30.70	30.10
8:00	25.30	33.20	32.70	31.90	31.20	31.70	30.90	30.20
9:00	25.40	33.40	32.90	31.80	31.30	31.50	30.80	30.00
10:00	25.50	33.30	32.80	32.00	31.40	31.90	30.90	30.10
11:00	26.00	33.60	32.90	32.10	31.40	31.90	30.90	30.20
12:00	26.30	33.90	33.50	32.70	31.40	32.40	31.00	30.50
1:00 p. m.	26.50	33.90	33.40	32.60	31.50	32.30	31.20	30.40
2:00	26.50	33.90	33.50	32.70	31.50	32.30	31.10	30.40
3:00	26.70	33.95	33.60	32.75	31.70	32.40	31.40	30.50
4:00	26.50	33.90	33.50	32.70	31.50	32.40	31.50	30.70
5:00	26.00	33.60	32.20	32.30	31.20	32.20	30.90	30.50
6:00	25.80	33.40	33.00	32.30	31.00	32.00	30.70	30.20
Average rise in temp...		7.60	7.20	6.32	5.44	5.71	5.10	4.40

TABLE V.—*Results of smudging.*

Set.	Tree No.	Smudging. Date begun.	Smudging. Date stopped.	Results.	Remarks.
June July		(1921-1922)			So rainy that fire could not be kept burning
Aug.	1	Aug. 2	Aug. 24	Flowered sparsely	Flowers were destroyed by fungus
	2	Aug. 2	Aug. 25	Flowered sparsely	
	check			No flower	
Sept.	1	Sept 10	Sept. 30	Flowered sparsely	Flowers were destroyed by rain and strong wind
	2	Sept. 10	Oct. 5	Flowered sparsely	
	check			No flower	
Oct.	1	Oct. 12	Oct. 25	Flowered abundantly	Fruits were formed quite abundantly
	2	Oct. 12	Oct. 21	Flowered abundantly	
	check			No flower	
Nov.	1	Nov. 3	Nov. 16	Flowered abundantly	Fruits were formed abundantly
	2	Nov. 3	Nov. 16	Flowered abundantly	
	check			No flower	
Dec.	1	Dec. 10	Dec. 22	Flowered abundantly	Fruits were formed abundantly
	2	Dec. 10	Dec. 24	Flowered abundantly	
	check			No flower	
Jan.	1	Jan. 2	Jan. 15	Flowered abundantly	Fruits were formed abundantly
	2	Jan. 2	Jan. 16	Flowered abundantly	
	check			No flower	

TABLE IV.—*Smudging records.*

Tree No.	Smudging.			Condition.	Temperature in tree.	Temperature in check.	Temperature increase	Flowers.	Remarks.
	Begun.	Ended.	Days.						
	(1921-1922)				°C.	°C.	°C.		
1	Aug. 2	Aug. 24	12	Mature	30.80	26.30	4.50	Sparse	Flowers destroyed by fungus.
2	Aug. 2	Aug. 25	13	Mature	30.65	26.30	4.35	Sparse	Flowers destroyed by fungus.
3	Sept. 10	Sept. 30	20	Mature	29.75	26.00	3.75	Sparse	Flowers destroyed by rain.
4	Sept. 10	Oct. 5	25	Mature	28.20	26.00	2.20	Sparse	Flowers destroyed by rain.
5	Oct. 12	Oct. 25	13	Mature	30.90	26.40	4.50	Abundant	Fruiting abundant.
6	Oct. 12	Oct. 21	9	Mature	33.50	26.40	7.10	Abundant	Fruiting abundant.
7	Nov. 3	Nov. 16	13	Mature	31.50	27.20	4.30	Abundant	Fruiting sparse because of hoppers.
8	Nov. 3	Nov. 16	13	Mature	31.60	27.20	4.40	Abundant	Fruiting abundant
9	Dec. 10	Dec. 22	12	Mature	30.60	26.00	4.60	Abundant	Flowers destroyed by hoppers.
10	Dec. 10	Dec. 24	14	Mature	30.00	26.00	4.00	Abundant	Flowers destroyed by hoppers.
11	Jan. 2	Jan. 15	13	Mature	30.30	26.20	4.10	Abundant	Fruiting abundant.
12	Jan. 2	Jan. 16	14	Mature	30.30	26.20	4.10	Abundant	Fruiting abundant.
13	Dec. 23	Jan. 8	16	Mature	31.10	27.10	4.00	Sparse	Fruiting sparse.
14	Dec. 24	Jan. 5	12	Immature	30.15	26.40	3.75	None	Tree came into flush.
15	Dec. 24	Jan. 10	17	Mature	29.15	26.40	2.75	Sparse	Fruiting sparse.
16	Dec. 24	Jan. 7	14	Mature	30.40	26.40	4.00	Abundant	Fruiting abundant.
17	Dec. 23	Jan. 7	15	Mature	30.35	26.50	3.85	Sparse	Fruiting sparse.
18	Dec. 23	Jan. 4	12	Mature	30.50	26.50	4.00	Abundant	Fruiting abundant.
19	Dec. 24	Jan. 20	27	Immature	30.35	26.40	3.95	Sparse	Fruiting sparse.
20	Dec. 26	Jan. 12	17	Mature	30.15	26.70	3.80	Sparse	Fruiting sparse.
21	Dec. 26	Jan. 11	16	Mature	30.60	26.70	3.90	Abundant	Fruiting abundant.
22	Dec. 23	Jan. 21	29	Immature	30.40	26.50	4.00	Abundant	Fruiting abundant.
23	Dec. 26	Jan. 7	12	Mature	31.80	26.70	5.10	Abundant	Fruiting abundant.
24	Dec. 24	Jan. 21	28	Immature	30.30	26.40	3.90	Abundant	Fruiting abundant.
25	Dec. 23	Jan. 22	30	Immature	30.35	26.50	3.85	Abundant	Fruiting abundant.
26	Dec. 26	Jan. 5	10	Mature	33.45	26.70	6.75	Abundant	Fruiting abundant.
27	Dec. 20	Jan. 16	27	Immature	30.35	26.20	4.15	Sparse	Fruiting sparse.
28	Dec. 16	Dec. 25	9	Mature	33.30	26.30	7.00	Abundant	Fruiting abundant.
29	Dec. 16	Dec. 24	8	Mature	33.50	26.30	7.20	Abundant	Fruiting abundant.
30	Dec. 18	Dec. 28	10	Mature	33.40	26.40	7.00	Abundant	Fruiting abundant.
31	Dec. 17	Dec. 28	11	Mature	32.20	26.30	5.90	Abundant	Fruiting abundant.
32	Dec. 19	Dec. 28	9	Mature	33.30	26.20	7.10	Abundant	Fruiting abundant.
33	Dec. 19	Dec. 31	12	Mature	30.50	26.20	4.30	Abundant	Fruiting abundant.
34	Dec. 19	Jan. 20	32	Immature	30.20	26.20	4.00	Abundant	Fruiting sparse.
35	Dec. 20	Jan. 9	20	Mature	28.55	26.20	2.35	Sparse	Fruiting sparse.
36	Dec. 21	Jan. 8	18	Mature	29.25	26.10	3.15	Abundant	Flowers destroyed by fungus.
37	Dec. 21	Jan. 17	27	Immature	30.30	26.10	4.20	Abundant	Fruiting abundant.
38	Dec. 22	Jan. 5	14	Mature	30.05	26.30	3.75	Abundant	Fruiting abundant
39	Dec. 22	Jan. 4	13	Mature	30.30	26.30	4.00	Abundant	Fruiting abundant.
40	Dec. 24	Jan. 5	12	Mature	30.45	26.40	4.05	Abundant	Fruiting abundant.

COMMERCIAL CITRUS PRODUCTION IN BATANGAS PROVINCE AND MEANS OF IMPROVEMENT[1]

By Crispulo G. Bagui

INTRODUCTION

There have been investigations on citrus plants in the Philippines and some articles have been published. Wester's work (1) dealing with the situation in the citrus district of Batangas was published in 1913 and that of Lyon (2) about commercial orange production in the Philippines in 1908. Mackie (3) and Reinking (4) deal with the botanical and pathological sides of the subject and the geographical distribution.

In the present article the writer attempts to discuss the commercial status of the citrus industry in Batangas Province and to suggest means by which it could be improved.

RELATION OF CITRICULTURE TO AGRICULTURAL DEVELOPMENT IN BATANGAS PROVINCE

Citriculture plays an important part in the agricultural development of Batangas Province. A considerable income is derived by the inhabitants from the cultivation of a variety of *Citrus nobilis*, commonly known as *naranjita*.

The Manila Railroad Company kindly furnished the following data which show the quantity of oranges transported by that company in the three years from 1918 to 1920.

TABLE I.—*Shipments of naranjita from Batangas Province in 1918-1919-1920.* a

	1918	1919	1920	Total
	kg	*kg.*	*kg.*	*kg.*
Santo Tomás	2,847	82,330	112,655	197,832
Tanauan	683,455	2,007,573	4,611,291	7,302,319
Luta . .	2,211	19,306	23,405	44,922
Santo Toribio. .	426	6,076	150	6,652
Lipa	1,492	76,756	7,039	85,287
San José	325,074	598,506	184,931	1,108,511
Batangas	169,334	84,680	359,181	613,195
Bauan B. .	33,583	23,284	21,595	78,462
	1,218,422	2,898,511	5,320,247	9,437,180

a The shipments of naranjita recorded in Table I were made from the stations given direct to Manila.

Mr. Higgins, former president of the Manila Railroad Company, estimated shipments of oranges from Batangas in 1909 and 1910 to be 737,646 kilograms and 812,833 kilograms respectively (5). Comparing these figures with those of Table I, it is seen that the orange exports from Batangas are increasing rapidly.

In spite of the increase in production the supply of citrus fruit in the Philippines is always far below the demand, as is shown by the fact that this country

[1] Thesis presented for graduation from the College of Agriculture, No. 148; Experiment Station contribution; No. 118.

imports every year mandarins, oranges, and pummelos from China; oranges, lemons, and pomelos, or grapefruit from California and Australia; and oranges and lemons from Italy and Spain (1). There appears, then, to be a good home market for citrus, and certainly one to encourage the development of the industry.

CLIMATE AND SOIL IN BATANGAS PROVINCE AND THEIR RELATION TO CITRUS GROWING

In a place where citrus growing is to be developed the climatic conditions as well as the soil must be carefully considered. Batangas enjoys the climatic conditions of the second type (6). The heaviest rainfall occurs from June to October; the medium, in November, December, April, and May; and the lowest from January to March. There are very distinct wet and dry seasons.

The citrus areas may be roughly grouped and designated as Northern, Southern, and Central in the order of their importance as citrus-producing regions. The towns which comprise the Northern, are Tanauan and Santo Tomas; the Southern, San José, Batangas, and Bauan; and the Central, Lipa, Luta, and Santo Toribio.

It is a noteworthy fact that in the districts where there is the highest moisture content of the air there is the largest supply of oranges. For instance, in Tanauan the orchards are situated mostly around Taal Lake. The southern district is much influenced by the breezes from Batangas Bay, a body of salt water.

There is a wide range of soils adapted to the growing of mandarins in Batangas. There is the fine loam of Boot, Balele, and the adjoining barrios, in the town of Tanauan; the heavy clayey soil of Batangas, Bauan, and San José; and the red adobe of Lipa, Santo Toribio, and Luta. In all these soils the mandarins do well, provided the soil is deep and well drained.

HISTORY OF CITRUS CULTURE IN BATANGAS

EARLIEST CULTIVATIONS

Not even an approximate date can be given as the beginning of citrus cultivation in Batangas Province, but the commercial cultivation began about 1872. According to Mr. Ruperto Laurel of Tanauan, there were trees sparsely scattered in the town about the middle of the last century. It is believed that the seeds used in the first planting on a commercial scale about 1872 came from those trees. In 1872, José Martin, an Augustinian Friar, started the planting of mandarins by the inhabitants of the town. Every Sunday after mass he called the "Capitan" (president of the municipal council) and "Teniente del Barrio" (Council members from each of the villages in the municipality) together in the convent and discussed with them the planting of mandarins on a large scale. Sixteen years later, that is, in 1888, there was a large production of mandarins in Tanauan.

According to Mr. Whiting's compilation relative to the industrial history of several towns in Batangas, as cited by Wester (7), the towns of Tanauan and Santo Tomas were locally noted for mandarins when the wheat blight struck these localities in the seventies. But according to Mr. Laurel there were no commercial plantings of any size before 1872. These two towns, Tanauan and Santo Tomas, passed an ordinance in that year requiring every land owner to

plant a certain number of mandarin trees. This ordinance remained in force for some years with the result that thousands of young citrus trees were propagated and set out. In this way the *naranjita* orchards came into existence.

METHOD OF CULTIVATION

In the early period of the industry the most common way of planting the seedlings was to place them in thickets of madre de cacao (*Gliricidia maculata*). Later, the madre de cacao trees, except a few left for shade, were cut down, and the leaves and stems left for mulch.

With this method of setting out the mandarin plants the orchard is not cultivated until after the first or second years of fruiting. At this period, shade trees are cut down, oftentimes the roots are dug up, and the mandarins are left unshaded; cultivation then becomes possible. Plowing and harrowing are done very close to the trees and very often not only the roots but also the trunks are injured.

During the more recent years the cultivation of the trees from their beginning is practicable since the land used for the orchard is planted to other crops. Rice, corn, and vegetables are grown as subsidiary crops between the trees until they have attained their full growth. In some cases the orchard is used as a pasture. Usually, except in a few well-kept orchards, the full grown trees appear to be given little or no cultivation at all. Even with this little care and attention given to the young plants, the trees produce superior mandarins and in such quantities as to attract much attention.

INFLUENCES ON DEVELOPMENT

Market conditions.—When the citrus industry was in its infancy the fruit was locally consumed. Later, when the planters in Tanauan and Santo Tomas produced more fruit than the people in those localities could consume some was sold to neighboring towns in Batangas Province, as Lipa, San José, Batangas, and Bauan. The people in these places seeing that Tanauan and Santo Tomas people were making money out of this crop planted mandarin trees.

One thing which brought outside demand for these mandarins is their superior quality. Wester (1) states that perhaps nowhere else in the world have superior mandarins been produced in such quantities as in Batangas Province. But no matter in what quantity they are produced, Batangas mandarins find a ready sale. So far there has never been an overproduction.

Transportation.—In 1888, that is sixteen years after the establishment of mandarin orchards in Tanauan, there was a larger production of mandarins than the people in the town could consume. So they exported the surplus to Laguna Province, principally to the municipalities of Calamba, Mamatid and other towns along Laguna de Bay, Calamba being the center of the trade. Transportation was not easy as there was no way of shipping the fruit except over trails and rough roads by men packing it; on horse back; in carreton; or, in a few cases, carretela. With the improved highway and the larger use of the carreton and carretela the outside demand increased. Consequently, citrus planters added each year a number of trees to their orchards. The eagerness to plant more trees was intensified by the news that the Manila Railroad would be extended to Batangas. So by the time the Batangas line reached its terminus in 1909 there were 547 hectares in Batangas Province planted to mandarins. These produced

6,211,500 fruits according to the estimates by Cruz (5) of the Bureau of Agriculture.

Mr. Higgins, president of the Manila Railroad Company, estimated shipments from Batangas Province to Manila for the years 1909-11, as follows: (5)

Year.	Tons.	Calculated number of oranges.
1909	726	5,260,000
1910	8,000	68,000,000
1911	427	3,000,000

The low figures for 1909 are accounted for by the fact that this branch of the railroad was completed late in the year and that large shipments were made by other means of land transportation and by water prior to completion of road. The great injury which the crop suffered from the eruption of Taal volcano in 1911 explains the low production of that year.

Diseases and pests.—Diseases and pests of citrus in the citrus districts in Batangas did not receive much attention during the early period of the industry, so very little is known as to the cause of damage either to the trees or the fruit. In the latter part of 1888, the parasite *Loranthus philippensis* Cham. was known to cause trouble in citrus groves; it is still a serious pest. An insect which the growers call *atangia* causes damage by making punctures in the skin of the fruit, thus rendering it unfit for market. It is reported, also, that this insect causes the fruit to fall. No specimens of this insect could be found by the writer. It is possible that the injury reported may have been caused by the citrus rindborer (*Prays citri* Miller) which is the larva of a moth. The female lays its eggs in the rind and when these are hatched the larvae produce protuberances on the rind.

In the investigation made in 1920-21, the writer collected specimens of diseases and pests. The diseases and pests found and the degree of damage to two kinds of citrus are recorded in Table II.

TABLE II.—*Diseases and pests attacking citrus of commercial importance, C. nobilis and C. mitis and the degree of attack on each citrus in the four principal citrus regions*

Diseases.		Hosts.	Places found and degree of attack.			
Common name.	Scientific name.		Tanauan.	San José.	Batangas.	Santo Tomás.
Citrus canker	*Pseudomonas citri* Hasse	*C. nobilis*	Severe	Severe	Slight	Severe
		C. mitis	Severe	Severe	Severe	Severe
Gummosis	*Diplodia.*	*C. nobilis*	Very severe	Severe	Very severe	Very severe
		C. mitis	Severe	Severe	Slight	Severe
Bark rot	*Diplodia.*	*C. nobilis*	Severe	Severe	Severe	Severe
		C. mitis	Severe	Slight	Severe	Severe
Dieback of twigs (Exanthema)		*C. nobilis*	Very severe	Very severe	Very severe	Very severe
		C. mitis	Slight	Severe	Slight	Slight
Damping off	*Sclerotium* sp.	*C. nobilis*	Slight	Slight	Slight	Slight
		C. mitis	Slight	Slight	Slight	Slight
Black mold or sooty mold	*Meliola citricola* Syd.	*C. nobilis*	Slight	Slight	Slight	Slight
		C. mitis	Slight	Slight	Slight	Slight
Insect pests.						
Black Palatoria	*Palatoria zizyphus* Lucas	*C. nobilis*	Severe	Slight	Severe	Severe
		C. mitis	Severe	Slight	Severe	Severe
Green scales	*Coccus viridis* Green	*C. nobilis*	Slight	Severe	Slight	Slight
		C. mitis	Slight	Slight	Slight	Slight
Scales	*Icerya seychellarum* Westw.	*C. nobilis*	Severe	Severe	Severe	Severe
		C. mitis	Slight	Slight	Slight	Slight
Black citrus plant-lice	*Toxoptra aurantii* Boyer	*C. nobilis*	Severe	Severe	Severe	Severe
		C. mitis	Severe	Severe	Severe	Severe
Leaf miner	*Phyllocnictis citrella* Stainton	*C. nobilis*	Very severe	Very severe	Very severe	Very severe
		C. mitis	Severe	Severe	Very severe	Severe

It is impossible to state when any of these insects and diseases first appeared, because very little attention was paid to them by the growers. Probably both the insects and diseases have been present for many years, although some may have not been recognized as pests by the owners of the trees. It is important to note that in all citrus regions investigated, scales and aphids are constantly held in check by their natural enemies, such as fungi, both the black and the red, and ladybirds.

PRESENT STATUS OF THE INDUSTRY

EXTENT OF CITRUS CULTURE

The principal citrus places in Batangas Province, named in the order of their production, are: Tanauan, San José, Batangas, Santo Tomas, Lipa, Bauan, and Luta, all of which are located on the railroad. However, in every municipality in the province one or more of the following varieties is grown to some extent: Calamunding (*C. mitis* Blanco); cahel (*C. aurantium* L.); lime (*C. medica* L.); pummelo (*C. decumana* L.); and mandarin (*C. nobilis* Lour). All these may be present in one locality, but no one of them is grown on a commercial scale except the mandarin; and this only in the seven towns mentioned.

METHODS OF PLANTING

Distance.—There are four systems of planting citrus: They are known as quincunx, hexagonal, square, and triangular, but the square system is the only one used in Batangas. In this system the rows of trees intersect each other at right angles and cultivation may be carried on in two directions.

The seedlings are planted either by the growers themselves or by hired laborers under the supervision of the growers. The latter method is preferred, because in this way the work can be accomplished quickly.

There is a good deal of variation throughout Batangas in regard to the number of seedlings planted to a hectare. Most growers plant only 300 seedlings with the view of intercropping the orchard up to the time the trees are full grown. Others plant as many as 400 seedlings to a hectare with the idea of having more trees per unit area and more fruit without regard to the inferior quality of the fruit produced. Their idea is that the more trees planted to the hectare the more fruit there will be. This, within limitations, may be confirmed by the results up to the time the trees are from 15 to 20 years old. When this age is reached the citrus growers begin to wonder why their orchards decrease in production. This falling off in production leads, oftentimes, to the neglect of the orchard. *Loranthus* is not pruned out, decaying twigs and dead branches are not removed, weeds are allowed to dominate the whole orchard, and the trees are left to struggle along without care.

It was found by the writer that the distance at which the trees are giving fairly good yield is five meters each way. The maximum distance for mandarins in Batangas Province was found to be six meters each way.

Subsequent care.—The question often arises as to the advisability of growing intercalary crops between the trees so as to get some revenue from the land while waiting for the trees to come into bearing. Such a practice is permissible only when such a crop does not interfere with the best growth of the citrus trees. The planting of corn, mungo, cowpeas, and vegetables, such as garlic and mustard, is used to advantage up to the fifth, or even to the tenth year after setting out

the trees. The tilling of the soil connected with these crops gives at least four advantages. It improves the physical condition of the soil by loosening it and extending the root area; it aids in saving moisture by enlarging the water-holding capacity and by checking surface evaporation; it augments chemical action thus making inert plant food available; and it admits air to the soil.

The practice to be condemned is the neglect of the orchard entirely, except at the harvest time, after intercrops are no longer planted. This practice is not uncommon among the Batangas citrus growers. Some, however, weed their orchards two or three times a year; and some not only weed but cut out the decaying branches and dead twigs and also the *Loranthus*.

ANNUAL OUTPUT OF CITRUS

Table III shows the commercial output of citrus exclusive of the local consumption for the years 1918, 1919, and 1920 in the eight places in Batangas Province which produce mandarins on a commercial scale.

The shipping of the oranges presents no difficulty to the growers. The orchards in most cases are near good roads; labor is cheap; and the freight trains go direct to Manila. With these advantages, growers can make sales in Manila direct to dealers. In this way the citrus growers, themselves, can get the market price instead of letting middlemen make a good profit.

ENCOURAGEMENT OF GOVERNMENT TO CITRUS GROWING IN THE PROVINCE

As the industry has grown, it has reached a higher development along many lines. The methods of tillage, of propagation, of planting, and of protecting the plants against pests, among the best growers are far in advance of what they were ten or even five years ago. These improvements are traceable chiefly to governmental aid to the industry through agricultural inspectors and the agricultural experiment stations at Tanauan and at Lipa.

Since the establishment of the commercial citrus industry at Darasa, Tanauan, many of the citrus growers practice better methods of tillage; the propagation of trees by budding; and the treatment of fungus diseases, such as gumming and bark rot, by the use of carboleneum. The last two improvements were begun about the close of 1920. Bordeaux paste has been found beneficial; its use should be more widely adopted by the large growers.

ECONOMICS OF THE INDUSTRY

EXPENSES IN OPENING AN ORCHARD

Cost of seed.—Where budding is the method of propagating citrus the first step in the production of a citrus tree is the raising of the root of stock upon which the desired variety is to be budded. But in the districts of Batangas the propagating method employed is the production of citrus trees directly from seeds.

The seeds in all cases are not bought. One who wishes to establish an orchard and who does not have even a single citrus tree either buys the seedlings at 20 centavos each or gathers fallen fruit under the trees and establishes a nursery himself. Discriminating growers oftentimes buy a few fruits from selected trees for the purpose of getting the seeds. The fruit can be bought for from three to four pesos a hundred in times of plentiful harvest or at times of low prices. From 100 fruits about 2200 seeds can be secured, as 22 seeds is the average seed content of each orange fruit (5).

TABLE III.—*Annual output of oranges for 1918-1920 of the eight important citrus-producing localities in Batangas Province.* [a]

Stations.	1918 Oranges.		1919 Oranges.		1920 Oranges.		Total Oranges.	
	kg.	*No. of fruits.*	*kg.*	*No. of fruits.*	*kg.*	*No. of fruits.*	*kg.*	*No. of fruits.*
Santo Tomás	2,847	20,583	82,330	595,245	112,655	814,495	197,832	1,430,323
Tanauan	683,455	4,941,379	2,007,573	14,514,752	4,611,291	33,339,633	7,302,319	52,795,764
Luta	2,211	15,985	19,306	139,573	23.405	169,218	44.922	324,776
Santo Toribio	426	3,079	6,076	43,929	160	1,084	6,652	48,092
Lipa	1,492	10,787	76.756	554,945	7,039	50,891	85.287	616,623
San José	325,074	2,350,355	598,506	4,327,198	184,931	1,337,051	1,108,511	8,014,604
Batangas	169,334	2.224,284	84,680	612,336	359,181	2,597,878	113,195	5,434,498
Bauan	33,583	242,795	23,284	169,343	21.595	156,131	78.462	567,269
Total	1,218,422	9,809,247	2,898,511	20,956.321	5,320,247	38,466,381	9,437,180	69,231,949

a Weights furnished by Manila Railroad Company.

Cost of growing seedlings.—Seeds are grown in boxes 35 by 50 by 12 centimeters. From 14 petroleum boxes, 20 boxes of these dimensions can be made. The cost of these 14 empty boxes is ₱2.80; the making of the 20 propagating boxes takes a carpenter one day, wages at ₱1.20; thus making a total cost of ₱4.00 for boxes. The cost of preparing the soil is ₱2.40. It takes six months to grow seedlings ready for transplanting into the nursery. The watering of the seed boxes during these six months is attended to by a boy earning ₱240 a year, including his board. According to the citrus growers one fourth of the ₱240, or ₱60, is sufficient allowance for the watering, because the boy usually devotes three quarters of his time to other work.

The 20 boxes hold from 3000 to 4000 seedlings. These seedlings are transplanted into the nursery by four workmen and cared for during one year, each man devoting about one fourth of his time to the work and each being paid the equivalent of ₱240 a year, including his board. It takes one year to grow the seedlings in the nursery before they are ready to be planted in the field. At this time they can be sold for 20 centavos a seedling.

Table IV shows the cost of growing seedlings and the revenue from their sales.

TABLE IV.—*Cost of growing seedlings; revenue from their sale; profit.*

Items.	Expenses.	
	Pesos	
14 petroleum boxes at 20 centavos each.	2 80	
Labor cost of boxes.	1 20	
Cost of preparing the soil..	2 40	
Cost of watering and caring for seed flats..	30 00	
Cost of transplanting seedlings and nursery care	240 00	
Rental value of land.	1 20	
Total.		277 60
Receipts from sales..		600 00
Risk and profit..		322 40

Cost of preparing the land.—The land used for orchards in Batangas Province is of two kinds; hilly places covered with a thicket of madre de cacao, ipil-ipil, et cetera, or more level lands previously planted to rice, corn, sugar cane, or vegetables.

If the piece of land selected for the orchard is covered with small trees and bushes, one of two plans is adopted—partial clearing or complete clearing. The general practice is for the landowner to give the use of the land to a tenant for a period of two years free of charge for the growing of cultivated crops on condition that the land be kept clean and that citrus trees be planted by the tenant who receives one peso for each tree in good condition. Where partial clearing is made the orchardist makes a different contract with the tenant. When the trees are about one and a half meters high, the landowner pays one peso for every tree planted. Since there are from 300 to 4000 trees on a hectare the tenant gets from 300 to 400 pesos besides the benefit he has gained from planting vegetables or other crops. If the land is clean, that is, has been previously planted to other crops, no work is needed in its preparation except digging the holes, which item comes under cost of transplanting.

Cost of transplanting.—The nurseries are located near the houses of the growers to facilitate their care and management, consequently they may be a few kilometers from the field where the seedlings are to be planted. This adds to the cost of transplanting.

The seedlings are lifted from the soil and not balled. This is done by first softening the soil around the plants by watering them, then with the aid of a *dolos* (Tagalog) a dibble-like tool, the plants are gently pulled up. The seedlings are then arranged in a carreton for hauling and some soil put on the roots to prevent them from drying. It requires half a day to prepare 300 seedlings ready for transportation to the field.

The total expenses of the grower for the preparation of the seedlings, together with their transportation to the field, amounts to from ₱2.60 to ₱3.25 a hectare. For the transplanting, the laborers are paid by the number of holes dug and planted. The transplanting costs the grower from ₱30 to ₱40 depending upon the number of seedlings planted to a hectare.

Summing up all the expenses for transplanting a hectare, the cost amounts to from ₱32.60 to ₱43.25, or an average of ₱37.93

Subsequent care.—To have a successful orchard, besides the suitability of soil and climatic conditions for citrus plants there are several other points to be considered. As has been stated, few Batangas citrus growers keep their trees pruned by cutting off the decaying branches and dead twigs which may be the result of either insect or fungus attack or from malnutrition of the trees; also, only a few keep their trees pruned from *Loranthus*. Weeding is also much neglected. The grower who keeps his orchard in good condition spends as much as ₱15 a hectare a year for removing the dead branches and the parasites, and ₱12 for weeding. This outlay, however, is more than paid back by the extra crop and the extended period of the profitable life of the orchard. These and other necessary expenses may be summarized as follows:

TABLE V.—*Annual cost per hectare of operating a bearing orchard of mandarin.*

Pruning (removing *Loranthus*, dead branches, etc.)	₱15 00
Weeding	12 00
Propping	4 50
Taxes	4 69
Total	₱36 19

In estimating the amount of capital required to conduct a bearing citrus orchard for a year the estimates in Table V may be found of value. The cost of superintendence, administration, and depreciation are omitted.

AGE AT WHICH TREES BEGIN TO BEAR

The seedling mandarin begins to bear fruit when from seven to ten years old, depending largely upon the kind of soil in which it is planted and the care given it. The soil in the barrios of Boot, Balele, Janopol, Bagbag, Wawa, and in the adjoining regions around Lake Taal is sandy loam and free from hard pan. It is believed that for this reason the citrus trees in these barrios bear fruit younger than in other places in Batangas Province.

YIELD PER TREE AND PER UNIT AREA

During the first three years of fruiting an average of from 275 to 400 fruits a tree may be harvested when conditions are favorable for the production of mandarins; on the other hand, during adverse climatic conditions the yield a tree may fall to 50 fruits, and sometimes there is no harvest. A medium yield for trees of this age is considered to be 100 to 200 fruits a tree. From this time until the trees have been in bearing for ten years there should be a constant increase in annual production until they produce 3000 fruits a tree in good years, providing, of course, the trees have good care.

COST OF HARVESTING

Batangas oranges are harvested from December up to late February. The harvesting is done by men, women, and children, who are paid five centavos per hundred or a lump sum for harvesting the orchard. The first way is by far the most common as it is fair to both parties and involves less risk. The lump sum plan is resorted to in emergencies, such as may arise from typhoons or a need for immediate sale of all the fruits.

Citrus growers estimate cost of harvesting to be from ₱40 to ₱60 a hectare when the trees are from seven to ten years old; this may increase to ₱450 for a plentiful harvest from a full-grown orchard.

MARKETING

There are three different methods in Batangas of disposing of a citrus crop. It may be sold for a lump sum on the trees to an itinerant speculator who attends to the picking; or it may be contracted for by large hotels or by large market dealers in Manila and delivered as needed by the growers; or it may be sold in local markets in Batangas and neighboring provinces.

Large growers sometimes prepare to sell the fruits by the first method and thus be insured against losses due to typhoons, drought, and low prices which may prevail during harvest. Speculators usually make contracts with the growers when the fruit is still very green. Another reason for large growers selling their fruit by this method is that they escape the trouble of handling the fruit. The method of selling to local markets is followed only by the small growers.

There may be a question as to which of these methods is to be preferred. There are many instances in which the speculators have made from 50 to 75 per cent net profit. A striking instance known to the writer is the case of a grower in Tanauan, who in 1919 sold the fruit from 6 hectares for ₱8000 to a speculator who sold it for ₱12000 to another speculator who in turn sold it for ₱14000. Thus ₱6000 was made on this grower's fruit before it reached the Manila market.

The oranges are taken to the railroad station in a carreton. a full load being about 3000 oranges or approximately the yield of one full-grown tree. The cost of transportation depends upon the length of the haul, but may be estimated at approximately 50 centavos a kilometer.

RETURNS PER TREE AND PER UNIT AREA

Four of the largest plantations ranging from two to six hectares each and a one-half hectare orchard were visited for the purpose of securing data on the relation of cost and returns. It was not difficult to get comparatively exact figures on the sale of the crop in each case, but it was impossible to get anything but estimates on the cost of operation, because none of the growers consulted had done any cost accounting. Table VI shows exact data on the size of orchard, the number of trees, approximate average age of trees, and the total amount received by the owner for the crop while on the trees in 1919 which was a good citrus year. The figures of cost of operation, excepting taxes which are a known quantity, were based on estimates of the cost of each different operation gathered from a considerable number of growers.

TABLE VI.—*Comparison of expenses and returns from sales.*

Serial number of units.	Area.	No. of trees.	Age of trees.	Cost of operation (estimated).					Amount received for crop.	Gain.		
				Pruning.	Weeding.	Propping	Taxes.	Total.		Per Orchard.	Per tree.	Per hectare.
	Ha.		*years*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
1	6 00	1,790	25	90.00	72.00	27.00	28.14	217.14	8,000.00	7,782.86	4 348	1,297.143
2	2 00	700	15	14 50	24 30	10 28	7.60	56.68	3,150.00	3,093.32	4.419	1,546.160
3	2 00	553	16	—	17.65	11.20	6.45	35.30	2,839.00	2,803.20	4.293	1,401.600
4	0 52	177	30	7.80	6 24	—	2.44	16.48	725.00	708.62	4.003	1,362.540
5	1 50	525	11	—	—	9.00	5.16	14 16	2,892.00	2,877.94	5.481	1,918.560
Totals....	12 02	3,845	89	112.30	120.19	57.48	49.79	339.76	17,606.00	17,365.84	22.544	7,526.000
Average...	2 404	319 9	17 8	26.06	24 04	12.296	9 95	67 952	3,525.20	3,473.168	4.508	1,505.200

From Table VI it may be seen that the average receipts for the crop were ₱3,473.16 per hectare. If the estimate of cost be correct the net gain was ₱4.50 per tree or ₱1505.20 per hectare.

POSSIBLE MEANS OF IMPROVING THE INDUSTRY

Neglect and improper cultural methods are unquestionably the principal causes of low yields and of the death of the trees. Better culture is the first and most essential step in the renovation of the orchard and the eradication of the diseases prevalent in it. The following suggestions are offered:

1. All decaying branches and the rot resulting from bark diseases should be painted with whitewash or carboleneum to prevent infection from fungus diseases. The organism causing the disease known as gummosis is *Diplodia* and it was found by the writer to produce gumming in from ten to fourteen days after artificial infection. When carboleneum is used care should be taken not to let it run over the healthy bark as it is very poisonous.

2. In many places it appears to be possible to have irrigation and where this can be done at a reasonable expense it would frequently prevent the loss of a crop and would result in a better crop nearly every year. There are many streams from which to get water and in places the water level is near the surface. Parts of the citrus districts are in artesian well areas.

3. The trees should be set farther apart than the usual method of planting, say, five or six meters each way.

SUMMARY

There are eight principal citrus places in Batangas, namely, Tanauan, San José, Batangas, Santo Tomas, Lipa, Bauan, Luta, and Santo Toribio, named in the order of their importance as citrus centers. The people in these places derive a considerable income from citrus growing.

The demand for citrus is always greater than the supply as shown by the fact that the Philippines annually imports citrus fruits from China, California, Australia, Italy, and Spain.

Climate and soil conditions in Batangas Province appear to be suitable for citrus growing if proper methods of management are employed. The industry would have died out because of neglect had it not been for the suitability of mandarins to climate and soil conditions there. The mandarin does not seem to be particularly exacting as to soils so long as the physical condition is good and there is no hard pan near the surface.

The cultivation of the soil in the orchard for the purpose of planting cereals or vegetables extends very close to the trees, and the roots and trunks are often injured. This gives a good chance for fungi to enter and develop in such cuts and bruises.

At least six fungi and six insect pests are doing much damage to citrus at the present time and a good many trees die because control measures are not practiced. Dead twigs and decaying branches are not removed; weeds are allowed to dominate the orchard; and *Loranthus philippensis* apparently is unnoticed.

Good harvests of fruit are obtained from trees set five meters apart. The maximum distance of plants found in Batangas Province was six meters each way. Trees set closer together than five meters become slender and spindling as they grow old and do not bear large fruit.

If the grower is a good salesman it is frequently more profitable for him to sell his fruit direct to large consumers or to market dealers than to sell to speculators.

The cost per hectare for establishing a mandarin orchard and maintaining it to bearing age, including cost of land, is estimated to vary from ₱700 to ₱800.

As the industry is commonly conducted in Batangas, there is no fertilizer, tillage, irrigation, or mulching applied to the orchard after it arrives at bearing age.

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CURRENT ECONOMICS OF TROPICAL PRODUCTION: I

The present article is the first of a series of brief summaries on the economics of tropical crops which are intended to inform the readers of *The Philippine Agriculturist* of significant factors and agencies, and movements of considerable moment to our production.

RUBBER

Rubber has held the stage of public attention above all other tropical crops during the past few months. It has been elevated to the position of an international question where, in company with mineral-oil and sugar, it looks down on its more humble companions, the fibers, cereals, roots and the vegetable oils.

Twenty years ago rubber came only from Brazil and a few jungle points in West Africa, where it was collected by inefficient semi-savages from low yielding wild plants. But fifty years ago an enterprising and not too conscientious plant explorer spirited a few seeds out of Brazil, which had an embargo on exportation of its rubber seed, and now we find the Brazilian rubber tree at home in the Federated Malay States and the East Indies generally.

Comparing the sources of the world's rubber supply of 1900 and 1921 we find the following remarkable changes:

Source.	World's supply.	
	1900	1921
	per cent	*per cent*
Brazil and West Africa	100	10
Malay Peninsula....	0	70
Dutch East Indies .	0	20

Add to this the fact that in 1900 the world consumed about 70,000 tons of rubber while in 1921 the world consumed 330,000 tons, and the rapid rise and stupendous importance of this tropical agricultural industry is at once expressed.

Rubber is a necessity in two of the greatest and most flourishing industries, electrical accessories and automobile tires, and in an endless number of minor fabrications.

The geographical division of production, a normal and wholesome thing in the main, has resulted in the gravitation of 70 per cent of the world's raw rubber production to the confines of the British Empire. On the contrary, and resulting from American pre-eminence in manufacture of tires and electrical goods, the production of 50 per cent of the world's finished rubber articles occurs within the continental boundaries of the United States. When geographical division

of production draws enigmas so marked as in this case there come about powerful counter influences, mostly political, and to some extent basically uneconomic.

A nation, especially one of the American temperament, delights in self-sufficiency. Despite this fact, the United States might well have continued content in its rubber partnership with Britain were it not for the action of the British Colonial Office last November when heavy export duties were placed upon all production of rubber over 60 per cent of the bulk of the 1920 crop. The 1920 colonial crop was 344,000 tons, so the export duty becomes effective whenever, in the future, production rises above 206,400 tons. In 1922, the United States required 280,000 tons and the rest of the world an equal amount. The price of crude rubber responded to the embargo, going from 15 cents to 37 cents a pound, an increase of 250 per cent.

The export duties, under the conditions of the market, give the producers of the British Empire, and to some extent the middlemen, a virtual control of rubber. American rubber manufacturies have large holdings in the Empire but they, too, will have to pay the tax. There is absolutely no denial of British right and justice in placing the tax. The United States has ever been protectionist—protectionist in cotton, protectionist in steel. It is, of course, a fact that American protection is paid largely by the domestic consumer, whereas, the proposed rubber tax would be paid largely by the foreign importers of rubber, not by the British consumer. In the long run, it may, with fair logic, be said that the tax would encourage manufacture of tires and other rubber articles within the Empire, thus restricting purchase from the United States by British consumers. American political economy of the past fifty years has thoroughly approved of the theory of local protection in industry, although the Constitution forbids export taxes.

But just as reasonably as the United States may take no justified umbrage of the British tax on rubber, neither may the United Kingdom and its Dominions condemn with sincerity any attempt on the part of the United States to locate a more favorable producing area for its essential supply of rubber crudes. To term this attempt "bombast" and a "lick-creation" scheme is a type of journalism borrowed perhaps by British editors from our own Mr. Hearst.

The United States Government has voted half a million dollars to investigate the most desirable area in which to develop a tax-free production of rubber. The Bureau of Forestry of the Insular Government of the Philippine Islands has proposed a bill which would open up more land than the present laws permit (a paltry 2,500 acres) to centralized private leasehold with liberal renewals but with rather unattractive rentals. The bill has the approval of the Governor General; of the Legislative leaders, and if the figure on rentals can be adjudicated, also of several large manufacturers.

The possibilities of rubber production on a large scale in the Philippines rest principally upon the removal of the area restrictions on leaseholding. The control of this point is completely in the hands of the native Filipino. He, alone, may modify or change. Whether or not rubber production will be established in Mindanao depends upon effecting a most decided change in legislative policy.

There have been three phases in the attitude of the Philippine Government relative to investment of foreign capital in the Islands. The first Philippine Commission professed to welcome overseas investments of capital but made its

coming in large units impossible by placing a strict limit on the area and period of tenure of the vast unoccupied public domain. The exclusionist position taken by the doughty gentlemen of the First Commission has been explained by the editor of the Shanghai *Far Eastern Review* as a movement to protect the cane and beet sugar producers of the American continent. However, it appears more likely that the action was taken from a more worthy motive: to conserve the land of the Philippines for Filipinos alone. The policy was also in harmony with the generally extreme emphasis on conservation which obtained in the America of Roosevelt's time, an emphasis which has dulled Alaska, and, perhaps, the Philippines also. At all events, the policy did keep out predatory interest, much needed pesos, and equally valuable commercial and industrial stimuli.

The second phase of the Philippine land situation was the same as the first in effect. The Philippine Legislature, since its controlling position in 1916, has tightened the conditions and dealt most niggardly with applicants for sizable investments. This must not be presumed to have been merely a continuation of the Commission's policy. It was political and not economic. For the past fifteen years the Filipinos have been attaining and consolidating their political autonomy. Their leaders rightly assumed that if the bars were let down to foreign investment, the consummation of their aspirations would have been difficult to say the least. They were neither dense nor stingy, merely wise.

The third attitude on foreign leasehold of land begins with the present year. The process of autonomy having been carried to such a point that no considerable modification by the Metropolis is possible, the Filipinos assured by the tact and force of Leonard Wood that the administration of the Islands under the aegis of the Republican party is finally no more detrimental to national aspirations than the lack of administration under the Democratic party, feel at liberty to loosen up a bit.

Mr. Manuel Quezon, President of the Senate, in a recent address in the College of Agriculture brought out clearly the changing attitude of the legislature towards foreign capital. In his address to the graduates of the University of the Philippines, Regent Palma went further in suggesting that the failure to open up to investment might lead a following generation to condemnation of the present as unwise trustees. It has come to be realized that every year in which cogonals are kept out of cultivation adds a debit to our economic system —lowers the ratio of effective to potential wealth. Potential wealth is a fine thing, but it feeds no one, shelters no one, clothes no one. The present generation of the Islands cannot capitalize the land and it were better, economically, to lease it, let it be cleared, let it be fertilized, drained, surveyed, and let standing crops be placed upon it under nominal rental leases for from 40 to 60 years and so augment its value when the time comes that the native son is ready to take up its capitalization. It is far more shrewd to let another man paint than do it yourself, as Tom Sawyer discovered. This thesis is fortified if the owner, himself, has not the paint to apply nor the money wherewith to purchase it.

The fact, of course, remains, that twenty years of influence against foreign leaseholds under anything like attractive conditions may have worked its ends so well that ten more will be required to shift the popular sentiment. The former job was so well done that a change presents political problems.

However, with the possibilities of a change in the national attitude towards outside capital, with optimum rubber production conditions in Mindanao, with the Yankees stirring up the seven seas to escape the rubber tax, the Philippines, today, entertain brighter prospects than ever before of a rubber industry. And this may be said with good grace to our British cousins, that if we do start rubber, the chances are we shall finish it and that without permanent detriment to their interests, because the most conservative curves drive the 1950 demand for rubber above twice the present production.

EVETT D. HESTER,
Of the Department of Rural Economics.

COLLEGE AND ALUMNI NOTES

Dean Charles Fuller Baker went on leave of absence March 19. He is expected to return to the College sometime in July. During his absence, Professor Evett D. Hester is in charge of the Dean's Office.

Professor Harold E. Woodworth presented his resignation to the University in January. He is now connected with a commercial firm in California.

Professor J. Edgar Higgins left on April 6 for a trip to the United States where he will join Mrs. Higgins and his son who graduates from Annapolis Naval Academy in June. Professor Higgins is expected to return in September. During his absence Assistant Professor Mariano B. Raymundo is in charge of the Department of Agronomy.

Professor D. A. Herbert spent the month of May collecting botanical specimens in the Mountain Province.

Associate Professor Emma S. Yule returned from leave on April 4 and resumed her position as head of the Department of English.

Assistant Professor Ruth Taylor left on March 25 for the United States having resigned her position in the Department of English.

At the Commencement Exercises of the University of the Philippines held in Manila on April 4, 1923, the degree of Master of Science was conferred on: Angel A. Africa, '20; José M. Capinpin, '20; Esteban G. Collado, '19; Leon G. Gonzalez, '22; Fernando de Peralta, '19; Emiliano R. Roldan, '19; Victor S. Sulit, '19; Alejo T. Taleon, '21; Deogracias B. Villadolid, '19.

On the same occasion the honorary degree of Master Farmer was conferred on Florentino Cruz, '16, and Gregorio M. Francisco, '17. Mr. Cruz is a livestock farmer and Mr. Francisco, a grain farmer. The only other graduate who has been thus honored is José Zamora, '11, farmer of Silang, Cavite.

Nemesio Catalan, '20, Second Lieutenant in the 45th Infantry, Philippine Scouts, has been detailed to relieve Second Lieutenant P. C. Sevilla of the 57th Infantry in the same organization as assistant commandant in the 2nd Regiment U. P. corps of cadets, at Los Baños. Lieutenant Sevilla will be stationed at Corregidor.

Doctor Mendiola of the Genetics division and Doctor Uichanco of the Entomology department spent the second week of April on the different haciendas operated by the Mindoro Sugar Company.

A party under the leadership of Professor Elayda, Director of the Extension Service of the College, visited the citrus plantations of the towns of Tanawan and Sto. Tomas, Batangas, to investigate in a preliminary way the citrus situation in those districts. The members of the party were Doctor Mendiola of Division of Genetics, Doctor Uichanco of Entomology Department, Doctor Santos of Chemistry Department, Dr. Fronda of Division of Poultry, Mr. Peña of Animal Husbandry Department and Professor Raymundo. The party was escorted by José de Leon, '17, superintendent of the Tanawan Citrus Experiment Station of the Bureau of Agriculture.

In April, Doctor Uichanco of the Department of Entomology, spent a number of days in Balayan, Batangas, to investigate sugar cane insects. While there he was given valuable assistance by Mr. Telesforo Chuidian, a local haciendero.

A campaign is now being waged vigorously by the officers of the College of Agriculture Alumni Association to raise the necessary funds for the long talked about Alumni Hall on the Campus. The proposed plan is to raise about ₱12,000 by selling stock at ₱10.00 a share. A portion of the building will be used for dormitories to be rented to faculty members, to residents of the association, and to some seniors. From this rental the association hopes to be able to pay the annual interest on the capital and eventually pay back the capital also. Here is a chance where outsiders interested in the College of Agriculture can do their bit. Those interested may communicate with the President, College of Agriculture Alumni Association, Los Baños-College, Laguna.

Hilarion G. Henares, B. S. C. E., '19, instructor in Sugar Engineering in this College, was married on April 28 to Miss Concepción Maramba at the bride's farm home in Sta. Barbara, Pangasinan. The acquaintance leading to this happy consummation began at the University of Illinois, where Miss Maramba studied home economics and Mr. Henares, mechanical engineering. Mrs. Henares is at present head of the Department of Home Economics, University of the Philippines.

Severo G. Yap, '21, Superintendent of Momuñgan Agricultural Colony writes that if any alumnus of the College of Agriculture wants to acquire land, he better go to this colony where he can select a good farm for himself.

Tomas D. Harder, '19, was a visitor in the College from April 21 to 24. Mr. Harder is stationed at the La Paz Demonstration Station in Iloilo, and was on an official trip to study the various phases of agriculture connected with his work.

Marcelo Crisostomo, '15, is now farming in La Castellana, Negros Occidental. He has been out of the government service since 1920.

DIRECTORY OF THE COLLEGE OF AGRICULTURE ALUMNI ASSOCIATION, 1923

Abadilla, Francisco, '17, Catanawan, Tayabas.
Abesamis, Ambrosio, '21, Alabang, Rizal.
Abrajano, Quirico, '22, Los Baños, Laguna.
Acuña, Eulogio, '23, Los Baños, Laguna.
Adriano, Alfredo P., '14, Tokyo, Japan.
Adriano, Felipe T., '19, Los Baños, Laguna.
Africa, Angel A., '20, Los Baños, Laguna.
Africa, Emilio, '18, Sariaya, Tayabas.
Agati, Julian, '21, Los Baños, Laguna.
Alas, Benedicto C. de las, '21, Los Baños, Laguna.
Albano, Sotero F., '13, Vigan, Ilocos Sur.
Alcaraz, Felix, '21, Alabang, Rizal.
Alcasid, Exequiel, '19, Alabang, Rizal.
Aldaba, Vicente C., '15, care Philippine Educational Agent, Bureau of Insular Affairs, Washington, D. C.
Aldaba, Victor C., '21, Muñoz, Nueva Ecija.
Allas, Teofilo P., '21, Camiling, Tarlac.
Allarey, Vicente, '12, care Bureau of Agriculture, Manila.
Almazan, Pascual, '22, San Pablo, Laguna.
Antenor-Cruz, Gregorio J., '23, Isabela, Negros Occidental.
Aquino, Dionisio I., '21, Los Baños, Laguna.
Aquino, Emilio C., '23, Pagsanjan, Laguna.
Aquino, Severino S., '22, Los Baños, Laguna.
Aragon, Vicente B., '18, Tarlac, Tarlac.
Asunción, Silvestre, '12, care Bureau of Agriculture, Manila.
Asunción, Rodolfo, '21, Bulan, Sorsogon.
Aurelio, Catalino G., '15, Banga, Capiz.
Babao, Santiago, '22, Batangas, Batangas.
Bacol, Simeon D., '22, Loway, Bohol.
Bacomo, Pantaleon U., '16, Cuyo, Palawan.
Bagui, Crispulo G., '22, Los Baños, Laguna.
Bagui, Florencio G., '13, Batangas, Batangas.
Balangue, Cornelio R., '16, Tuguegarao, Cagayan.
Baltazar, Eulalio P., '22, Los Baños, Laguna.
Bartolome, Vicente C., '13, care Bureau of Agriculture, Manila.
Baybay, Domingo, '21, La Carlota Experiment Station, La Carlota, Occidental Negros.
Bayla, Arsenio, '18, care Bureau of Agriculture, Manila.
Bautista, Basilio, '18, Montalban, Rizal.
Bautista, Pantaleon, '18, Malabon, Rizal.
Bengzon, Arturo, '23, Camiling, Tarlac.
Bernardo, Francisco, '21, Los Baños, Laguna.

Buenaventura, Agapito E., '22, Catarman, Samar.
Cabanos, Juan B., '19, care Bureau of Agriculture, Manila.
Cagurangan, Alfonso, '16, Ilagan, Isabela.
Calingasan, Teofilo, '17, Malaybalay, Bukidnon.
Camus, José S., '14, care Bureau of Agriculture, Manila.
Canonizado, Maximo P., '20, Pagsanbangan, Tagum, Davao.
Capinpin, José M., '20, Los Baños, Laguna.
Capistrano, Severo M., '15, care Bureau of Agriculture, Manila.
Carandang, Atanacio T., '20, Pampanga Sugar Central Development Co., San Fernando, Pampanga.
Caray, Elias, '21, Los Baños, Laguna.
Carreon, Felix D., '23, Los Baños, Laguna.
Catalan, Nemesio, '20, Ft. Wm. McKinley, Rizal.
Cazeñas, Gregorio, '20, Dao, Antique.
Celis, Eugenio D., '23, Pangil, Laguna.
Cendaña, Silverio M., '21, Los Baños, Laguna.
Cevallos, Felipe, '12, care Bureau of Education, Manila.
Chanco, Antonio R., '19, care Bureau of Agriculture, Manila.
Chandrastitya, Iang, '21, care Department of Plant Breeding, Cornell University, Ithaca, N. Y., U. S. A.
Clara, Feliciano M., '20, care Bureau of Agriculture, Manila.
Clemente, Leopoldo, '17, Los Baños, Laguna.
Clinton, Guy, '16, care Bureau of Insular Affairs, War Department, Washington, D. C.
Cocannouer, Joseph A., '18, Chauchilla, Calif., U. S. A
Collado, Esteban, '19, Los Baños, Laguna.
Collado, Isidoro, '20, Ballesteros, Cagayan.
Collado, Tomas G., '22, Los Baños, Laguna.
Constantino, Agripino, '15, Morong, Rizal.
Constantino, Marcelino, '16, Indang, Cavite.
Consunji, Gaudencio, '16, Hermosa, Bataan.
Corcino, Baltazar, '22, Capiz High School, Capiz.
Corrales, José P., '20, Mambajao, Misamis.
Crisanto, José, '23, Los Baños, Laguna.
Crisostomo, Marcelo, '15, La Castellana, Negros Occidental.
Cruz, Florentino, '16, Malaybalay, Bukidnon, Mindanao.
Cruz, Ramon A., '23, Los Baños, Laguna.
Cruz, Segundo M., '23, Montalban, Rizal.
Cuitiong, Rufino, '22, Deceased.
Dacanay, José Q., '15, care Publications Division, Bureau of Agriculture, Manila.
Dadufalsa, Tomas D., '22, care Tayuman Intermediate School, St. Cruz, Manila.
Dario, Leoncio, '19, care Bureau of Agriculture, Manila.
David, Pedro A., '19, Los Baños, Laguna.
Dawis, Vicente M., '16, Los Baños, Laguna.
Derecho, Antonio, '20, care Bureau of Agriculture, Manila.
Desembrana, Basilio D., '23, Los Baños, Laguna.
Dimaano, José L., '23, Lipa, Batangas.

Divinagracia, Delfin, '21, Los Baños, Laguna.
Edroso, Leon, '17, Abulug, Cagayan.
Elayda, Aniano, '20, care Bureau of Agriculture, Manila.
Elayda, Inocencio, '15, Los Baños, Laguna.
Erese, Valentin, '19, Deceased.
Esguerra, Felix M., '22, Los Baños, Laguna.
Esguerra, José P., '19, Los Baños, Laguna.
Esguerra, Juan D., '19, Cabanatuan, Nueva Ecija.
Espino, Rafael B., '15, Los Baños, Laguna.
Estalilla, Hilarion H., '20, Aringay, La Union.
Estioko, Roman P., '22, Los Baños, Laguna.
Estrada, Alberto A., '22, Los Baños, Laguna.
Ferrer, Laureano G., '23, Indang, Cavite.
Ferrer, Tomas G., '21, San Carlos, Pangasinan.
Festin, Santiago, '18, Davao, Davao.
Festin, Simplicio F., '20, Odiongan, Romblon.
Flores, Geronimo, '23, Lipa, Batangas.
Flores, Simeon, '17, Dumaguete, Oriental Negros.
Francisco, Gregorio M., '17, Sta. Rosa, Nueva Ecija.
Frigillana, Generoso R., '22, San Carlos, Pangasinan.
Fronda, Francisco M., '19, Los Baños, Laguna.
Galang, Francisco, '14, care Bureau of Agriculture, Manila.
Gamboa, Fermin J., '22, Los Baños, Laguna.
Gavarra, Perpetuo A., '23, Lagonoy, Camarines Sur.
Ghofulpo, Teodorico G., '15, Binalbagan, Occ. Negros.
Goco, Arsenio A., '17, care Bureau of Agriculture, Manila.
Goco, Lorenzo, '21, Los Baños, Laguna.
Gonzalez, Bienvenido M., '13, Los Baños, Laguna.
Gonzalez, Joaquin, '19, Apalit, Pampanga.
Gonzalez, Leon G., '22, Los Baños, Laguna.
Gordon, Alexander, '23, Los Baños, Laguna.
Goseco, Andres P., '20, Guagua, Pampanga.
Grageda, Gregorio, '17, La Union, Sigaboy, Davao.
Grano, Moises S. de, '21, Butuan, Agusan.
Gutierrez, Mariano E., '17, Pikit, Cotabato, Mindanao.
Guzman, Isidoro, '20, Cabagan, Isabela.
Habaluyas, Ramon K., '19, Malabon, Rizal.
Harder, Tomas, '19, La Paz Demonstration Station, La Paz, Iloilo.
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Hidalgo, Vicente, '19, Dumarao Stock Farm, Dumarao, Capiz.
Isidro, Rufino, '20, care Bureau of Science, Manila.
Jamias, Julio M., '20, Castillejos, Zambales.
Jimenez, Alejo L., '21, Los Baños, Laguna.
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Juliano, José B., '23, Los Baños, Laguna.
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Labayen, Segundo D., '15, Oriente, Cuba.
Labrador, Anselmo, '20, La Carlota Experiment Station, La Carlota, Occ. Negros.
Lacson, Prudencio S., '21, Malabon, Rizal.
Lago, Francisco P., '19, Los Baños, Laguna.
Laparan, Amando, '14, Sta. Cruz, Laguna.
Layosa, Pedro, '18, Deceased.
Lazerna, Ernedo T., '22, Los Baños, Laguna.
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Ledyard, Edgar M., '13, P. O. Box 1785, Salt Lake City, Utah.
Lejano, Antonio, '13, care Bureau of Agriculture, Manila.
Leon, José de, '16, Tanawan, Batangas.
Leoncio, Martin O., '23, Bustos, Bulacan.
Limbo, Anastacio, '20, Malaybalay, Bukidnon.
Lindayag, Gaspar, '19, Deceased.
Lipayon, Anastacio, '19, Chico, Calif., U. S. A.
Lizazo, Juan G., '20, La Carlota Experiment Station, La Carlota, Occidental Negros.
Lomibao, Patricio, '23, San Carlos, Pangasinan.
Lontok, Ambrosio, '20, care Bureau of Agriculture, Manila.
Lontok, Gregorio B., '20, Los Baños, Laguna.
Lopez, Enrique, '23, Los Baños, Laguna.
Luistro, Fernando, '20, Basilan, Zamboanga.
Mabbun, Pablo N., '23, Los Baños, Laguna.
Macasaet, Valentin, '18, Iwahig, Palawan.
Maceda, Felix, '20, care Bureau of Agriculture, Manila.
Maggay, Hilario T., '22, Tuguegarao, Cagayan.
Magsino, Juan R., '20, care Lincoln Primary School, Manila.
Malabanan, Pedro L., '23, Lipa, Batangas.
Mamaril, Julian A., '23, San Carlos, Pangasinan.
Manio, Melecio M., '19, Isidro, Nueva Ecija.
Manio, Ramon V., '20, Calumpit, Bulacan.
Mañalac, J. San Juan, '23, Baliwag, Bulacan.
Mañgonon, Alejandro, '20, Manauag, Pangasinan.
Manza, Artemio, '21, Los Baños, Laguna.
Mariano, José, '18, Bigaa, Bulacan.
Mariano, Severo J., '20, care Audubon Sugar School, Baton Rouge, Louisiana.
Marilao, Venerando P., '22, Maao Sugar Central Co., Inc. Pulupandan, Occidental Negros.
Marquez, Francisco D., '16, care Bureau of Agriculture, Manila.
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Mendiola, Nemesio B., '14, Los Baños, Laguna.

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Merino, Gonzalo, '14, care Bureau of Agriculture, Manila.
Mirasol, José J., '15, Cebu, Cebu.
Miniano, Geronimo, '21, care Bureau of Agriculture, Manila.
Miraflores, José C., '15, Manapla, Occidental Negros.
Moncerate, Benito N., '22, San Joaquin, Iloilo.
Mondoñedo, Mariano , Los Baños, Laguna.[1]
Montellano, Pedro L., '15, Muñoz, Nueva Ecija.
Morada, Emilio K., '20, Lamao, Bataan.
Morada, Julian A., '20, Lipa, Batangas.
Muñoz, Apolonio R., '13, Juban, Sorsogon.
Nación, Cipriano C., '23, Los Baños, Laguna.
Narabal, Tiburcio, '19, care Bureau of Agriculture, Manila.
Navarro, Andres, '12, Baguio, Mountain Province.
Neric, Juan I., '21, Camalig, Albay.
Nisce, Teofilo, '19, care Bureau of Agriculture, Manila.
Noguera, José, '19, Batangas, Batangas.
Novero, Teofilo, F., '22, Los Baños, Laguna.
Obias, Feliciano C., '21, Lagonoy, Camarines Sur.
Ocfemia, Gerardo O., '15, Los Baños, Laguna.
Octubre, Francisco P., '15, Rosales, Pangasinan.
Olofernes, Bernabé, '23, San Fernando, Pampanga.
Opiana, Gil O., '23, Los Baños, Laguna.
Otanes, Faustino Q., '18, care Bureau of Agriculture, Manila.
Padilla, Bonifacio, '22, Sta. Rosa, Nueva Ecija.
Padlan, Policarpo, '20, Lipa, Batangas.
Padolina, Felipe B., '18, Lamao, Bataan.
Paglinawan, Sergio, '23, Bacacay, Albay.
Pagsolingan, Juan G., '23, San Carlos, Pangasinan.
Paguirigan, Domingo B., '16, care Bureau of Agriculture, Manila.
Palafox, Gaudencio, '16, Gamu, Isabela.
Palafox, Serapio M., '20, San Nicolas, Ilocos Norte.
Panganiban, Elias H., '15, 123 Quarry St., Ithaca, N. Y.
Panganiban, Simeon, '20, Malabang, Lanao.
Pastorfide, Dionisio B., '17, Lucena, Tayabas.
Paz, Alfonso de la, '18, Lipa, Batangas.
Paulican, Cenon, '17, Bagumbaan, Bukidnon.
Paulino, Pedro, '20, care Bureau of Agriculture, Manila.
Peliño, Anacleto R., '22, Indang, Cavite.
Peña, Daniel B., '22, Los Baños, Laguna.
Peralta, Fernando de, '19, Los Baños, Laguna.
Pereira, Eufemiano de Braganza, '21, Goa, Portuguese India.
Piguing, Rafael M., '22, Los Baños, Laguna.
Ponce, Basilio F., '22, No. 6 Int. Cabral, Ermita, Manila.
Pugeda, Melquiades S., '20, Los Baños, Laguna.
Pulgar, German M., '22, Lingayen, Pangasinan.

[1] Member by election.

Punzalan, Edilberto S., '22, Los Baños, Laguna.
Quisumbing, Eduardo, '18, Los Baños, Laguna.
Quisumbing, Francisco, '14, care University of the Philippines, Manila.
Racelis, Antonio P., '15, care Bureau of Forestry, Manila.
Ramos, Florentino, '20, Deceased.
Raymundo, Mariano B., . . ., Los Baños, Laguna.[1]
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San Miguel, Lucio A., '16, Deceased.
Sanchez, Antonio C., '22, Clarin, Bohol
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HERE AND THERE AMONG AGRICULTURAL COLLEGES IN EUROPE

On my way home from my last period of study in America (1920-23) I spent some weeks in a number of countries in Europe with the purpose of study, travel, recreation, and to satisfy a curiosity as to how they did things there compared with the way we do things in the Philippines and in America.

Being engaged in educational work in the Philippines I was naturally interested in educational institutions, especially agricultural schools, and in these, more specifically in the animal husbandry work. Naturally, then, the observations that follow were made from a rather biased point of view. Having no mission to fulfill nor directions to bind me, I just followed my natural inclinations. The order I will follow in this description is chronological in the sense that I will take the countries in the order in which I visited them.

The agricultural colleges in Germany go under the name of *Landwirtschaftliche Hochschule.* Usually they exist as independent units, but sometimes they form a college in a university. There are seven of these colleges, all government institutions. There are innumerable elementary agricultural schools scattered over the country. The name *Hochschule*, or high school may be misleading to us who have a different conception of a high school. The German agricultural high schools are on the same level in academic standing as the other branches of the university—as liberal arts, law, and medicine, for example. Compared with the American agricultural colleges or ours, the college standing is a little higher, in the sense that the students on entering are already prepared to take technical work. Students entering the university must first graduate from the *Gymnasium*, which is the nearest equivalent of our high school. The *Gymnasium* goes a little farther than our high school, so that when the students are graduated they have had a number of the equivalents of subjects that are usually taught in the first and second years of an American college; for example, languages, both German and foreign, history and mathematics.

If the University of Halle, with which I am better acquainted than with any other in Germany, is taken as typical, the requirements for a diploma in agriculture are the completion of prescribed subjects in seven departments, usually one or two in each department, requiring in general six semesters of resident study. The students have considerable freedom in the selection of the departments where they wish to take work. The usual departments represented in the *Landwirtschaftliche Hochschule* are: agronomy, animal husbandry, agri-

cultural chemistry, bacteriology, rural economics, veterinary science, anatomy and physiology, plant pathology, geology, botany, zoology, etc. Two more semesters of work, during which time the student writes his final dissertation in his chosen department prepares him for the degree of Doctor of Philosophy. The German doctorate is both a first and a last degree and is conferred in practically all branches of human knowledge. The *diploma* may be considered as equivalent to the Bachelor degree in the Philippines, although it is not considered as a degree in Germany. There is no equivalent to the Master's degree. In all sincerity, however, and knowing the grade of work turned out in both cases, the Master's degree as granted in this College, *on an average*, is the closest equivalent to the German Doctor of Philosophy that I know—our degree not suffering in the comparison.

From the point of view of a Filipino student, German University life appears very lax. After matriculating, the student is pretty free to do as he pleases. There are no roll calls, hardly any quizzes and no periodic examinations. Before receiving credit in a specific subject, however, he must satisfy the professor as to his knowledge of the subject through a special examination or written report or *arbeit* on some designated topic. While there are some students who waste their first one or two semesters in the University, drunk with the new privileges unknown in the closely supervised *Gymnasium* whence they have just come, the average German student is a steady worker and a regular attendant in his classes. The German student laughs at the American methods of pounding knowledge into unwilling students—roll calls, demerits, quizzes, examinations, reports to parents, etc. He laughs with reason as they are superfluous in his case.

Owing mainly to the fact that students take care of themselves, the German professor is able to do considerable work in the way of teaching, research, and administration. Most German university departments have only the professor and his assistant as technical personnel. The huge departments in American universities, where one finds as many as five or more professors, are practically unknown or very infrequently encountered in Germany. This, of course, is due to a great extent to the fact that there are comparatively many more schools for the population and the units are not large.

As to the method of instruction in the German *Landwirtschaftliche Hochschule*, it is very theoretical. In animal husbandry, for example, judging consists in the instructor pointing out the strong points and defects of the specimen on hand—demonstration in reality. The judging pavilion, so conspicuous in the American college, is not known in Germany. I visited the three most famous departments of Animal Husbandry (*Tierzuchtinstitut*) in Germany, and found that only one of them had any animals at all. The one in Halle, nationally considered as far above the others, had a collection of rare specimens of domestic animals, such as Przewalski horses, Zebus (Indian Cattle), Karakul and African fat-tail sheep, Arabian horses, etc., which are kept really as the name given to the collection, *Haustiergarten*, or garden of domestic animals, implies as animals in a "Zoo" rather than as farm animals.

A considerable proportion of the courses given are exclusively lectures, many of them subjects in which considerable laboratory work is given in the United States. The German professor of animal husbandry makes a brave effort to reduce his field of work to an exact science. As experimentation with farm

animals is necessarily of long duration and expensive, his progress gauged by actual accomplishment has been somewhat slower than that of his brother in England or America who has trusted more to his intuition, artistic, and practical sense, than to well-controlled experimentation to attain his ends. What is lacking in equipment as to living animals is supplemented by models and charts. In this respect the equipment in German universities is superior to that of American Colleges.

BELGIUM

There is only one agricultural school of collegiate grade in Belgium. This is the *Institut Agronomique de l'Etat* and is located in the small city of Gembloux, about forty miles southeast of Brussels. The requirements for admission is the completion of the *Bachelier* course as given in the preparatory school, or *Lycée.* This is almost the exact equivalent of the *Bachiller en Artes* as formerly given by the Spanish *Colegios* in Manila.

Two courses are given: One of two years duration leading to a diploma of *Licencie en Sciences Agronomiques*, and a four-year course leading to the degree of *Ingénieur,* in some agricultural specialty. The subjects taught in the first course allow no choice. They are experimental physics and meteorology, general and analytical chemistry, geology, zoology and entomology, botany and plant pathology, general and specialized agriculture, general and specialized animal husbandry, rural engineering, accounting, agricultural technology, and law. In the second course the first two years are similar to the first course, but there is a separate curriculum for the last two years according to the specialty chosen. The degrees conferred are: Agricultural Engineer of Colonial Agriculture, Engineer of Waters and Forests, Horticultural Engineer, Rural Engineer, and Engineer of Agricultural Industries. The various curricula are very similar but differ in the emphasis laid on the subject in which the degree is given.

This particular school has herds of cattle, horses, hogs, and some chickens, experimental gardens, orchards, and an instructional and demonstrational farm. The quality of instruction given is more practical than that given in the German universities.

FRANCE

The *Institut Agronomique* at Paris is the highest agricultural school in France. There are three national schools of agriculture, one at Rennes, one at Grignon, and one at Montpelier, which are almost of the same grade as the one at Paris. The *Institut Agronomique* gives a two-year course, mostly theoretical, in general agricultural physics, chemistry, zoology, botany, plant pathology, rural engineering, animal husbandry, etc. The preparation required is equivalent, approximately, to two years beyond the French *Bachelier*, and grants the degree of *Ingenieur Agronome.* The three institutions of subordinate grade require the *Bachelier*, alone, for preparation and grant the degree of *Ingenieur Agricole.* The first institution maintains a high standard through limiting its attendance to two hundred students; applications number over double this figure.

There is also at Nogent Sur Marne an *Institut National d'agronomie Coloniale*, which is really a post-graduate school giving a one-year course to graduates of any of the schools named above, as preparation for colonial service. It confers the degree of *Ingenieur d'Agronomie Coloniale.*

Being crowded in the middle of the city of Paris, the *Institut Agronomique* has little practical work outside that conducted in the laboratories. Instruction is supplemented by trips to farms, stockyards, and the abbatoirs.

GREAT BRITAIN

There are at least seventeen schools in England giving instruction in agriculture; about half of them are of collegiate standing. Contrary to expectation agricultural instruction is as yet not well developed in England. This is because it is almost wholly in the hands of private enterprises. Of late years the government, through the Ministry of Agriculture, has made contributions towards the support of certain projects in agricultural schools already established, and has granted scholarships tenable at these institutions. The schools of best repute are the School of Agriculture of the University of Cambridge, and the School of Agriculture of University College at Reading.

The main course in both these institutions is the degree course in agriculture granting a Bachelor's degree in Arts at Cambridge and in Science at Reading. This course is from three to four years duration. The students mark their progress by passing the yearly examinations. The subjects taught include history of agriculture and forestry, agriculture and mensuration, forestry, physics, chemistry, geology, botany, zoology, engineering, veterinary science, economics and accounting, plant pathology, and agricultural law. Students begin to specialize in the second year and this may be in agriculture, estate management, forestry, or horticulture.

The examination in the English schools is used for a purpose quite different from that in American schools. In American schools examinations are given to find out how much the student has learned in a course, while in England the examinations serve as standards for which students prepare themselves, in the same way as the Supreme Court examinations for lawyers in the Philippines, or the different Board examinations for licensing physicians, pharmacists, dentists, veterinarians, etc.

There is also a diploma course in agriculture of two years duration offered at Reading which requires at least one year farm practice as a prerequisite. This is intended especially for prospective farm managers to give them a scientific background for their practical knowledge. They take courses in agriculture, chemistry, botany, zoology, bookkeeping, entomology and veterinary hygiene.

The diploma course as given by Cambridge is totally different from that given at Reading. It is a post-graduate course of one or two years for students wishing to specialize further in practical agriculture, or in some branch of agricultural science.

There is a subject offered in English agricultural schools no longer encountered in American colleges; this is agriculture. The obsolete title of Professor of Agriculture in America is still commonplace in England. In his more general field this professor teaches everything under the sun that has anything to do with agriculture, from plowing to the construction of farm buildings, and from bookkeeping to the treatment of animal diseases. In his more restricted field he takes charge of the major work on the farm, including crop farming, livestock and dairying, and farm management. Great Britain, the country that has produced about ninety per cent of our improved breeds of stock, has no professors

of Animal Husbandry, and the famous British judges of livestock did not learn to judge in school as judging is not taught in their agricultural colleges. The facts of the case are that the different breeds were developed by born stockmen long before agricultural colleges were even dreamed of. So the livestock industry of Great Britain developed rather independently of agricultural educational institutions. This state of affairs is quite at variance with that found in America where the development of livestock industries in many regions is directly traceable to the agricultural colleges.

HOLLAND

The national Agricultural College in Holland is located at Wageningen and is known simply as *Landbouwschool*. The course is of four years duration with an additional year of farm practice required between the third and fourth years. The degree of *Ingenieur* either in Agriculture, Forestry, or Dairying is conferred. I expected to find this school following the German system, but it is more like the French and Belgian schools. The college maintains herds. The excellent dairy herd and the cheese factory are illustrative of the work they emphasize in animal husbandry. The school also maintains the usual departments of agronomy, chemistry, botany, physics, etc.

GENERAL OBSERVATIONS

While getting acquainted in general with the institutions visited, I made special inquiries regarding three points:

1. What is the extent of the practical work given to agricultural students?
2. What scientific work is accomplished by students?
3. What is the usual life work of the graduates?

In commenting on the answers to these questions I shall compare the European institutions with American agricultural colleges as well as with our own College in order that an idea may be gained as to how we stand among our sister colleges.

1. It is well known that agricultural colleges in America require farm experience from their students, but practically give none in their courses. The different colleges visited in Europe require farm experience in varying amounts. Holland probably holds most rigidly to such requirements and Germany the least. The closest to practical work that I saw students engaged in in the colleges themselves, outside the laboratories, was to follow a professor around the instructional farm, listen to him as he pointed out the object of the different cultures and work going on on the farm, record observations, and otherwise study the workings and the system of management of the farm. I did not see students engaged in actual manual labor outside. This system is quite different from ours, where we do not require farm experience outside but try to give it to the students in the college.

2. I found that practically no scientific work is accomplished by undergraduate students. Everywhere they are just passive "absorbers" of information dealt out by the instructional force. Essays are often required in connection with the subject taught, but there is no attempt at originality in these papers outside of the presentation. While there may be an occasional college in America that requires a thesis from its students, I found none among the European colleges visited. This is one phase of work highly emphasized in our college.

3. A large majority of the graduates in the different agricultural colleges go into educational, investigational, or administrative work of some kind, usually carried on under the auspices of the government, such as teachers, livestock inspectors, county agents, officials in experimental farms, etc. In England, France, Belgium, and Holland a considerable number are sent to the agricultural development projects in their colonies. The richer graduates go back home to manage the family farm holdings. A number start modestly in enterprises of their own, or secure positions as assistant farm managers, or as technical employees where there are agricultural industries. In this respect I did not find the future of our graduates any different from those of the countries visited.

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RATE OF DECOMPOSITION OF ORGANIC NITROGEN IN RICE PADDY SOILS[1]

By ELIAS H. PANGANIBAN

The rate of decomposition of organic nitrogen in Philippine rice paddy soils under field conditions is a subject which has not been investigated as yet. The organic materials in the soils, through the activities of certain bacteria, are decomposed with the consequent production of carbon dioxide, ammonia, amino acids, and nitrates. In studies made of the rate of decomposition of organic nitrogen occurring in nature, two methods are frequently employed. One method consists in the measurement of the rate of carbon dioxide evolution at definite intervals; the other, in the determination of the rate of formation of ammonia or nitrate nitrogen. The conditions in rice paddy soils during a great part of the year is such as to inhibit nitrate nitrogen formation completely, for it was observed (1) that when the soil is submerged in water, nitrates are found only in traces or are entirely absent. This is due to the lack of proper aeration, a condition which is necessary to the process of nitrification. Of course during the time when the soils are not submerged, nitrates accumulate, but when the land is flooded such nitrates are subsequently lost in the form of free nitrogen as a result of the action of certain anaerobic organisms. Evidently, it is out of the question to correlate the rate of decomposition of organic matter with the rate of production of nitrate nitrogen in rice paddy soils.

On the other hand, ammonification experiments with soils (1) have been carried out with dried blood as the source of nitrogen. Using varying amounts of water, starting from the air-dry soil and increasing the amount of water up to and beyond the saturation point, it was found that active ammonification took place even in completely saturated soil, which condition is approximately similar to that in submerged rice fields. Very little study of ammonia formation in rice paddy soils has been made. So far as the writer knows, investigation has been made only in Hawaii (1) where rice is generally grown in paddies. Analysis of the rice soils taken from the field when wet had shown that they contained considerable amount of ammonia, varying from a few parts up to as much as 50 to 60 parts per million. This presence of ammonia suggests the possible correlation of its formation in rice paddy soils and the rate of decomposition of organic nitrogen.

No work has yet been done which would correlate the production of amino acids with organic nitrogen decomposition, and yet amino acids are degradation products of proteins in which form most of the nitrogen in the soil organic matter is found. Chardet (2), who used Sorensen's method found from 49 to 68 per cent of the soil nitrogen to be amino acid nitrogen. Using Kober's method, Potter and Snyder (2) found only 7.95, 23.10 and 23.10 parts per million of the soil, which figures, if expressed in percentage of total nitrogen in the soil, correspond

[1] Thesis presented for graduation with the degree of Master of Science from the College of Agriculture, No 149; Experiment Station contribution, No. 119.

to 0.53, 1.25 and 1.10 per cent, respectively. They claim, moreover, that by Sorensen's method no nitrogen in the amino form could be found.

There is no available work yet published of a field study of carbon dioxide evolution in rice paddy soils. In 1906, Stocklasa and his collaborators (3), working under laboratory conditions, concluded from their results that the carbon dioxide evolution from the soil was inhibited by anaerobic conditions. Fraps (4) in 1915, however, showed that there is active evolution of carbon dioxide even when the soil is saturated with water.

The purpose of this work was to study the rate of carbon dioxide evolution in rice paddy soils simultaneously with the determination of their total nitrogen, ammonia, and amino acid contents before and during the period of growth of rice.

EXPERIMENTAL

PLAN OF THE WORK

Plans were laid out to analyze the soils for carbon dioxide ammonia and amino acids under the following conditions:

1. When the paddies were lying fallow.
2. When the paddies had been plowed and were ready to be planted.
3. After the paddies were planted and were either dry or submerged.
4. When the rice crop was mature with the paddies still submerged.

The total nitrogen, and in some cases the nitrate nitrogen, was also determined.

PADDIES USED

Paddies A.—These are paddies covering about 2,400 square meters of ground, behind the Administration Building of the College of Agriculture. These paddies were made in 1915. Since that year they had been planted to rice during the wet seasons and allowed to lie fallow during the dry seasons. No nitrogenous commercial fertilizers had been applied to these paddies so that the nitrogen in the soil came mostly from the vegetable matter of the soil. The condition in all rice paddies in the Philippines is similar to these in respect to the origin of nitrogen.

Paddies B.—These paddies are behind the new Chemistry Building of the College, and occupy about 6,400 square meters of ground. They are about 40 meters from the building. They were made in 1917, and since then had been planted to rice during the wet seasons and to either legumes or corn during the dry seasons. During the dry season of 1920, the paddies were planted to corn; and after harvesting the ears the rest of the plants were allowed to decay in the paddies thus enriching the soil organic matter. This rotation of corn or legumes with rice is practiced in many rice sections in the Islands, though on a very small scale, so that the condition in respect to organic matter of these paddies is similar to those in many localities.

SAMPLING

The soil samples were taken from the different parts of the paddies at a depth of fifteen centimeters by means of a trowel previously sterilized in a flame. The samples obtained were placed in an empty kerosene can sterilized with formaldehyde a day or two before the sampling. From ten to fifteen samples were obtained from the paddies and these were mixed as thoroughly as possible in the laboratory with the same sterilized trowel. After mixing the soil, the moisture

content was determined at once and samples containing a definite weight of the soil were taken for the different determinations.

METHODS OF ANALYSIS

Carbon Dioxide.—For the determination of carbon dioxide, the writer used Fred and Hart's method and apparatus (5) with slight modifications. The apparatus set up for this experiment consisted of a suction flask of about a liter capacity connected to a long glass cylinder with a 50 cc. pipette. The glass cylinder was two-thirds full of glass beads and held the 10 cc. normal sodium hydroxide. The beads were used to give a greater surface and to prevent the carbon dioxide from passing too rapidly through the alkaline solution.

After the amount of moisture present in the soil was determined, the equivalent of 500 grams of dry soil was placed in the flask and incubated at room temperature. To drive the carbon dioxide into the sodium hydroxide solution, a current of air freed from carbon dioxide by passing it through soda lime was passed through the apparatus for 10 minutes every day. The carbon dioxide was determined for 6 days, at two-day intervals, by titrating the alkaline solution, using the double indicator method for carbon dioxide (6), with standard sulphuric acid solution, each cc. of which was equivalent to 2 milligrams of carbon dioxide. This acid solution was slightly weaker than the N/10 used by Fred and Hart, and was very convenient for it simplified the calculations of the results. The results were expressed in milligrams of CO_2 per 100 grams of soil.

Ammonia.—Ammonia was determined by aeration following the method devised by Potter and Snyder (7). The equivalent of twenty-five grams of the moisture-free soil was placed in a 500 cc. Kjeldahl flask and 50 cc. of ammonia-free water and a few drops of heavy oil to prevent foaming were added. Then the rubber stopper bearing the tubes for the entrance and exit of the air was put in place. An absorption bottle of about 500 cc. capacity was filled with a mixture of 200 cc. of ammonia-free water and 5 cc. of N/14 sulphuric acid. This solution was about twice as strong as that used by Potter and Snyder (7). The Kjeldahl flask was then connected with the absorption bottle, after seeing to it that there was no water adhering between the rubber stopper and the mouth of the flask to collect ammonia. As many as eight or ten determinations were run in one series. The air, before entering the apparatus, was freed from ammonia by passing through a wash-bottle containing dilute sulphuric acid. Before the pump was started all the rubber stoppers bearing the tubes for entrance and exit of the air were loosened from the flasks, about two grams of sodium carbonate were added to the first flask closest to the pump, the flask shaken and then the rubber stopper inserted. The other flasks were treated similarly. After 20 hours of continuous aeration, and while the pump was still on, the flasks were disconnected one after another, starting with the one farthest from the pump. Then the contents of the absorption bottles were titrated with N/14 standard alkali using alizarine sulfonate as indicator. The results were expressed in parts per million of soil.

Amino Acids.—The writer followed Potter and Snyder's method (2) of extracting amino acids and the copper and Kober's method (8) for the determination.[3] This method was used also by Potter and Snyder, with some modifica-

[3] This method will include the amino acids found in the cells of the soil micro-organisms

tions. Enough sample to give 150 grams of dry soil was weighed and placed in a bottle; 300 cc. of 4 per cent sodium hydroxide and enough water to give 600 cc. of 2 per cent alkali were then added. After shaking for two hours, the dark colored extract was filtered over night, instead of whizzing it in a centrifuge as recommended by Potter and Snyder (2). Eighty cc. of this solution was transferred to a 100 cc. flask and made almost neutral with 1-1 hydrochloric acid solution; 7 cc. of a saturated solution of lead acetate, 7 cc. of ammonium hydroxide (sp. gr. 0.90) to precipitate the excess of lead, and enough water to complete the volume to 100 cc. were added. The mixture was shaken thoroughly and then filtered. To 75 cc. of the filtrate, 25 cc. of saturated barium hydroxide were added, and the ammonia removed by boiling at a pressure of about 25 mm. The liquid was then made up to 75 cc., the barium carbonate precipitate filtered and 50 cc. of the clear solution placed in a 100 cc. flask. The solution was then made barely alkaline to phenolphthalein by the addition of concentrated hydrochloric acid, 40 cc. of the "buffer" solution added, and after cooling for two hours or more in an ice box, 1 cc. of the cooled suspension of freshly prepared cupric hydroxide in water was then pipetted in, made up to the mark with water and the whole was shaken, and finally filtered through Whatman Genuine filter paper No. 42. Fifty cc. of the filtrate were placed in a beaker, slightly acidified with 5 per cent nitric acid, heated to boiling, and bromine water added till a permanent color was given. The solution was then boiled down to about 10 cc. and in order to be sure that the last trace of bromine was expelled, 35 cc. of water was added and boiled down again to 10 cc. The solution was cooled, made slightly alkaline with sodium carbonate and made acid with glacial acetic acid. After the addition of potassium iodide and starch solution, the free iodine liberated by copper was titrated with sodium thiosulphate the normality of which was 0.001. Each cc. of this solution was equivalent to 0.0280 mgs. of total amino acid nitrogen. The results were expressed in parts per million of soil.

Total Nitrogen.—The writer used the official method for the determination of the total nitrogen (9).

Nitrates.—The modified phenol-disulfonic-acid method (10) was used. Two samples, each weighing the equivalent of 50 grams of dry soil, were placed in the shaking bottles, 5 grams of calcium carbonate and water were added. The amount of water added was such as to make the total weight of water including that already present exactly 200 grams. The bottles were shaken vigorously for one minute, three times, at half-hour intervals. The soil extracts were then passed through the filter and treated as follows: Five cc. of the filtrate were placed in porcelain dishes and evaporated to dryness on the water bath. When the dishes were cooled, 1 cc. of the phenol-disulfonic-acid solution was slowly poured around the dishes and allowed to spread over and soak the dry residue; the dishes were rotated so as to make sure that the acids came in contact with the nitrates. The dishes were then allowed to stand for 15 minutes, and then treated with about 15 cc. of cold distilled water. By means of a wash bottle, the solutions were made alkaline with dilute ammonium hydroxide (4 to 8 per cent) until the yellow color was permanent. The standard nitrate solution was treated in the same way. The unknown nitrate solution was then compared with the standard in a Schreiner colorimeter.

PRELIMINARY EXPERIMENTS

Before the series of experiments were conducted, according to the plan, trial experiments were run. The first of these was on the determination of ammonia nitrogen. Potter and Snyder (7) in their experiments used about 250 liters of air an hour for twenty hours. The only available pump in the laboratory permitted only about 100 liters of air an hour; so that tests were made to lengthen the time of aeration. Experiments using 20 hours, 27 hours and 44 hours of aeration were conducted, using samples of soils from the paddies behind the new Chemistry Building. The results are shown in Table I. The soil was taken December 2, 1919, when the paddies contained maturing rice and the ground was not submerged in water. The soil contained 26.43 per cent of moisture.

TABLE I.—*The results of the different time of aeration.*

Time of aeration	Samples	Mgs of NH_3-N in 25 gms. soil.	Parts per million.	Average. p.p.m.
20 hours	1	1 18	47.2	
	2	1.48	59.2	
	3	1.04	41.6	
	4	1.11	44.4	43.1
27 hours	1	0.81	32.4	
	2	0.81	32.4	
	3	0.89	35.6	
	4	0.89	35.6	34.0
44 hours	1	1.25	50.0	
	2	0.89	33 6	
	3	1.04	41.6	
	4	0.67	26.8	35.5

By comparing the results of 20 hours, 27 hours and 44 hours, it may be seen that the highest amount of ammonia nitrogen was obtained in the 20-hour aeration. The 27 and 44 gave too low results.

These lower results may have been due either to sampling or to a possible dissociation of ammonium sulphate formed in the receiving bottles during the longer aeration and a consequent loss of ammonia.

To obtain light on the second supposition, the following experiment was conducted:

Aliquots of the standard sulphuric acid with ammonia equivalent to that found in the trial experiment after 20 hours of aeration were placed in the receiving bottles with the usual quantity of ammonia-free water. Three of these preparations were aerated for 7 hours and three for 24 hours. Three others were used as blanks. The results are found in Table II.

TABLE II.—*Number of cubic centimeters of alkali used in titration.*

Aeration.	c. c. alkali.		
	I.	II.	III.
Blank....................	4.23	4.25	4.20
Aerated for 7 hours.......	4.20	4.22	4.26
Aerated for 24 hours......	4.15	4.22	4.20

Table II shows that the longer aeration did not cause any loss of ammonia, thus showing that the lower results obtained in Table I for the 27-and 44-hour aeration were probably due to poor sampling or to some other cause. Since no single determination in the 27-and 44-hour aeration gave higher results than the 20-hour, the latter was considered sufficient and was used in the following experiments.

The second trial experiment was on the determination of carbon dioxide evolution. The soil was from the paddies behind the new Chemistry Building, taken on February 17, 1920, after heavy rains and contained 24.33 per cent of moisture. The paddies had just been plowed after lying fallow. The results are presented in Table III. The total nitrogen of this soil was also determined and found to be 0.120 per cent.

TABLE III.—*Carbon dioxide evolved during 12 days.*

Two-day periods.	Mgs. carbon dioxide in 100 gms. soil.		
	I.	II.	III.
February 19, 1920. .	Lost	Lost	Lost
February 21, 1920.. .	15 14	14.39	15.98
February 23, 1920. . .	6 95	6 98	10 06
February 25, 1920..	3.06	3.25	4.32
February 27, 1920..	2.94	2.94	2.83
February 29, 1920. .	3.64	3.48	2.71
Total . .	31 73	31 04	35.90

It will be seen from Table III that the carbon dioxide evolution decreased rapidly after the sixth day, which result coincides with Frap's in his work (4) on the decomposition of cotton seed. The table gives concordant results.

EXPERIMENTAL RESULTS

PADDIES A

First Set.—Samples were taken April 20, 1920, while the paddies were lying fallow. The soil contained 20.22 per cent of moisture and 0.091 per cent of total nitrogen.

Second Set.—Samples were taken May 10, 1920, after two days of heavy rain and while the paddies were still lying fallow. The soil contained 31.95 per cent of moisture and 0.100 per cent of total nitrogen.

Third Set.—Samples were taken November 9, 1920, while the paddies were submerged and planted with rice. The soil contained 0.184 per cent of total nitrogen but no nitrate nitrogen.

Fourth Set.—Samples were taken December 12, 1920, while the paddies were submerged and growing maturing rice. The soil contained 0.219 per cent of total nitrogen but no nitrate nitrogen.

PADDIES B

First Set.—Samples were taken July 17, 1920, after several rainy days. The soil had been plowed and was ready for planting. It contained 24.77 per cent of moisture and 0.110 per cent of total nitrogen.

Second Set.—Samples were taken August 12, 1920. The paddies were growing rice, about two weeks old. The soil was drying and beginning to crack in places. It contained 17.80 per cent of moisture and 0.125 per cent of total nitrogen.

Third Set.—Samples were taken November 25, 1920, while the paddies were submerged and growing maturing rice. The soil contained 0.195 per cent of total nitrogen but no nitrate nitrogen.

Fourth Set.—Samples were taken December 29, 1920, while the paddies were submerged and growing maturing rice. The total nitrogen found was 0.209 per cent. It had no nitrate nitrogen.

(Table IV records the carbon dioxide evolved in 12 days in Paddies A and B.)[3]

DISCUSSION OF RESULTS

Taking the results in Paddies A for every individual set of analyses, it will be seen that during the dry season when the fields were lying fallow the carbon dioxide evolution from the soil, kept under laboratory conditions, was rather slow, while its ammonia content was relatively high, ranging from 58.0 to 77.6 parts per million. Its amino acid nitrogen averaged 8.82 parts per million. This was 0.969 per cent of total nitrogen in the soil. This result is within the range found by Potter and Snyder (2) for upland soils which was from 0.53 to 1.25 per cent of the total nitrogen.

The second set of analyses, where the sample was taken after two days of heavy rain and the soil contained 31.95 per cent of moisture, showed high rate of carbon dioxide evolution but low ammonia content. The amino acid nitrogen was found to be slightly lower, and the total nitrogen slightly higher than in the first set. This higher rate in the carbon dioxide evolution agrees with the results obtained by Lewis and Cunningham (3) in India, who found that the carbon dioxide in the soil studied increased after a rainfall. The low result for ammonia, on the other hand, was probably due to a more active nitrification of the soil because of the more favorable condition. Active rate of nitrification in Philippine soils (11) was observed when the soils contained a high percentage of moisture. The slight decrease in the amount of amino acids can be attributed to more active ammonification.

A comparison of the results from the first two sets of analyses seem to show that the rate of decomposition of organic nitrogen in the soils cannot be measured by ammonia or amino acid formation, alone. The first set showed a slow carbon dioxide evolution which amounted only to 15.69 milligrams per hundred grams of soil for a twelve-day period; while there was a large accumulation of ammonia, a fact which may have been due to very slow nitrification. In the second set, however, the reverse was true. There was a high rate of carbon dioxide evolution, but apparently slow ammonia and amino acid formation.

The third set of experiments with submerged soil, showed active carbon dioxide evolution, a result which was similar to that obtained by Fraps (4) with soils of very high moisture content. This set gave a decreased amount of ammonia, a slight increase in amino acid nitrogen, and a marked increase in total nitrogen.

The fourth set showed the same rate of carbon dioxide evolution as Set 3, but much less ammonia, and a greater amino acid and total nitrogen content.

[3] Four tables, one showing total nitrogen found in Paddies A and B in the four sets of experiments, one showing ammonia nitrogen; one showing amino acid-nitrogen; and one showing nitrate-nitrogen are omitted owing to lack of space in The Philippine Agriculturist. These tables are on file in the Chemistry Department of College of Agriculture where they may be consulted or copies will be furnished on application

In the first set of experiments in Paddies B, the carbon dioxide evolution and the amino acid and total nitrogen content did not show any noticeable differences from those for the corresponding periods of Paddies A. This indicates that the two paddies were similar in respect to their bio-chemical properties. The ammonia content, however, was only about one fourth of that found in the soil for the corresponding period in Paddies A when the soil was lying fallow. As previously stated, the samples were taken after several rainy days and after the paddies had been plowed and were ready for planting. In all probability, the ammonia formed during the rainy days was in great part transformed into nitrates, for nitrification was probably favored by higher moisture content and by better aeration brought about by plowing.

The second set of experiments showed a lower rate of carbon dioxide evolution, which coincided with a lower moisture content of the soil. It also showed less ammonia and amino acid nitrogen but more total nitrogen.

The third and fourth sets showed, as in Paddies A, more active carbon dioxide evolution when the soils were submerged. However, only traces of ammonia were found in Set 3, and 3.4 parts per million in Set 4, while the amount of amino acids and total nitrogen increased in both sets.

A summary of the results for both Paddies A and B is given in Table V. It may be observed that there seems to be a direct relation between the carbon dioxide evolution and the moisture content of the soil under aerobic condition, for a low percentage of moisture was accompanied by a low carbon dioxide evolution and a high percentage of moisture by a high carbon dioxide evolution. Brown (12) found that the decomposition of organic nitrogen in soil is largely accomplished by bacteria and that the number of bacteria in the soil decreased as the moisture decreased. If carbon dioxide evolution in soil is correlated with the bacterial activity then the results recorded in this paper are what might be expected. With respect to the differences in the nature of the nitrogenous matter in submerged soils as compared with those not submerged, it can be said that it may have been due to the differences in the bacterial flora. The bacteria acting on the organic matter in submerged soils were anaerobic, while those acting under the latter conditions were aerobic.

In both paddies, there was a decided increase in total nitrogen. The increase, however, was more appreciable when the paddies were submerged and when the rice was maturing or was already matured. Apparently the increase can be accounted for only through the process of nitrogen fixation. Greaves and Carter (13) showed that there is nitrogen fixation in both aerobic and anaerobic conditions. Fischer (15) (16) found that there was a good rate of nitrogen fixation in soils under water and considered that the significance of free living nitrogen-fixing bacteria, especially the aerobical and radiobacterial forms could be favorably compared with that of the nodule bacteria for the legumes. Further, he found that nitrogen fixing bacteria enriched tenfold the ground at the bottom of the pond, a condition practically similar to rice paddy soils under submerged conditions. This shows that there is an extraordinary nitrogen fixation in soils under water and Fischer explained that this excessive nitrogen fixation is due to (1) nitrogen fixation by lower fungi, (2) synthetic action of enzymes produced by the decomposition of protein compounds in the soils, (3) symbiosis between green water plants, especially algae and short bacilli of pneumonia group, and

(4) anaerobic bacteria. The above findings of Fischer may fully account for the findings reported in the present work. Why this fixation, if it took place in this particular soil, was more pronounced when the soil was submerged in water, may probably be explained by the reduced rate of ammonification and total absence of nitrification under anaerobic condition. Russell (14) states that the gain of nitrogen in the soil would not go on indefinitely. In course of time a point of equilibrium would be reached where further gains would be balanced by losses, so that the nitrogen content would remain constant; and thus there would be an upper limit as well as a lower limit to the nitrogen content, depending on the soil conditions, between which limits the nitrogen content might be maintained. Moreover, Russell said that direct plowing and cultivation operations as shown by the analyses of the Indian Head soil, caused a great loss of nitrogen and that only one third of the nitrogen lost was recovered by the crop. Thus a great part of the nitrogen accumulating in the rice paddies when submerged in water may be lost during the preparation of the soil for planting. Small losses would also be observed during aerobic conditions, for the decomposition of nitrogenous compounds under aerobic conditions may be accompanied by a loss of nitrogen (14).

Ammonia decreased in both Paddies A and B during submerged conditions. In the case of Paddies A, the ammonia found decreased from 66.70 parts per million when the soils were lying fallow to traces during the time when the soils were planted and submerged. This result agrees with those obtained by Kelley (1) who worked on rice paddy soils in Hawaii. In the discussion above, it is stated that there was active decomposition of organic nitrogen even under submerged conditions as indicated by active carbon dioxide evolution, and the fact that there was very little ammonia in submerged conditions in both paddies would naturally call for some explanation. What becomes of the ammonia nitrogen that would be formed during such decomposition? Quantitative test for nitrate nitrogen showed negative results. The partial or total absence of ammonia nitrogen in submerged soils can only be accounted for by the supposition that it was absorbed by rice as fast as it was formed and by the reduced rate of ammonification of the amino acids. Kelly (17) in Hawaii showed that lowland rice could assimilate nitrogen in the form of ammonia and that this form of nitrogen was rather preferred to nitrates by the rice plant.

In both Paddies A and B there was, however, a slight increase in the amino acid nitrogen content under submerged conditions although the percentage of this form of nitrogen in terms of total nitrogen was lower than under aerobic conditions, so that the increase of actual amino acids in the soil was not proportional to the increase of total nitrogen. A statement was made in the introduction to this paper that the amino acids were intermediate products of the decomposition of organic nitrogen. These amino acids are in turn de-aminized by organisms with the formation of ammonia. Kelley (1) showed that ammonification takes place even in soils under submerged condition although at a lower rate than under aerobic condition and with optimum moisture in the soil. The decrease of amino acid nitrogen in proportion to the total may be due either to reduced hydrolysis of the protein nitrogen or to direct assimilation of the amino acid nitrogen by the rice plant or to both. Potter and Snyder (2) pointed out that under certain conditions, amino acids may be utilized by the plants.

PRACTICAL APPLICATION OF THE EXPERIMENTAL RESULTS

It is known that the application of nitrogenous fertilizers in the form of ammonium salts to the soil increases rice production per unit area. In Hawaii, for example, investigators found that fertilization with ammonium salts produced a considerable increase in the yield of rice (1). Recent investigations (18) carried out at the College of Agriculture, University of the Philippines, showed that highest straw and highest grain yields were positively correlated with salt mixtures containing highest proportion of ammonium sulphate and lowest with those containing lowest proportions of the salt. The results of the present work show that there was very little nitrogen in the form of ammonia during the time the ground was submerged in water. There was of course accumulation of ammonia while the soils were lying fallow, but the accumulated ammonia was apparently rapidly converted into nitrates which were most likely denitrified as soon as the soils were flooded. These findings seem to show why the application of ammonium salts is favorable to rice.

The application of organic matter containing protein nitrogen to rice paddies, the usual practice in many localities, may prove beneficial under aerobic conditions, but not in submerged soils for its decomposition would be very slow, and would not produce enough ammonia nitrogen to supply the immediate need of the crop.

SUMMARY

1. During the dry season when the rice paddies were lying fallow, the decomposition of organic matter was slow as measured by carbon dioxide evolution, but there was a large accumulation of ammonia nitrogen.

2. There was an active evolution of carbon dioxide after heavy rains, and nitrification proceeded rapidly with the consequent conversion of ammonia nitrogen into nitrates.

3. The rate of decomposition of organic nitrogen can not be measured by the ammonia and amino acid content of the soil, for they may be transformed into other forms of nitrogen as fast as formed.

4. Carbon dioxide evolution was active even in submerged soils, but the ammonia present was much less than under aerobic condition.

5. The evolution of carbon dioxide under aerobic conditions was affected by the moisture content of the soils; the low percentage corresponded to low carbon dioxide evolution and the high percentage to high carbon dioxide evolution.

6. There was an appreciable increase of total nitrogen, presumably caused by nitrogen fixation.

7. The ammonia nitrogen content of the paddies was practically zero under submerged conditions probably due to a rather slow rate of decomposition and rapid absorption by rice.

8. Nitrates were absent in submerged soils.

9. There was a slight increase of amino acids in the soils under anaerobic conditions but this increase was not proportional to the increase in total nitrogen.

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TABLE IV.—*Showing carbon dioxide evolved during 12 days in Paddies A and B for the four sets of experiments.* (*Figures express milligrams of carbon dioxide per 100 grams of soil.*)

Paddies.	Set No.	Date.	Sample number. 1	2	3	Average.	Moisture.	Soil conditions.
		1920	*mg.*	*mg.*	*mg.*	*mg.*	*per cent*	
A	1	April 22	3.65	4.11	4.00		20.22	Paddies lying fallow
		April 24	3.09	2.92	3.08			
		April 26	2.15	2.50	2.38			
		April 28	1.71	1.94	1.77			
		April 30	1.25	1.54	1.54			
		May 2	1.38	1.54	1.52			
		Total . .	13.23	14.55	19.29	15.69		
	2	May 12	11.98	13.39	12.11		31.95	After two days of heavy rain and while the paddies were still lying fallow
		May 14	8.01	8.09	7.53			
		May 16	5.86	5.61	4.96			
		May 18	5.05	4.37	5.18			
		May 20	6.03	5.09	5.39			
		May 22	4.79	5.61	5.26			
		Total . .	41.72	42.16	40.43	41.44		
	3	Nov. 11	6.72	7.82	6.38		41.86	Paddies submerged and planted with rice
		Nov. 13	4.93	4.03	4.15			
		Nov. 15	3.32	3.28	3.36			
		Nov. 17	2.97	3.18	3.18			
		Nov. 19	3.49	4.05	3.45			
		Nov. 21	2.88	2.53	3.05			
		Total .	24.31	23.89	23.57	23.92		
	4	Dec. 14	6.57	6.79	6.97		40.58	Paddies submerged and rice maturing
		Dec. 16	3.90	3.94	4.07			
		Dec. 18	4.18	2.85	3.38			
		Dec. 20	3.63	3.25	3.34			
		Dec. 22	3.21	2.74	2.78			
		Dec. 24	3.34	2.74	2.85			
		Total . .	24.83	22.31	23.39	23.51		
B	1	July 19	4.59	4.98	4.21		24.77	After several rainy days Soil had been plowed and was ready for planting
		July 21	4.52	4.10	4.71			
		July 23	2.91	2.83	2.87			
		July 25	3.37	3.60	3.03			
		July 27	2.64	2.76	2.57			
		July 29	2.49	1.69	1.81			
		Total .	20.52	19.96	19.20	19.89		
	2	August 14	4.47	6.84	5.10		17.80	Paddies contained rice about two weeks old. Soil drying and beginning to crack
		August 16	2.96	2.82	2.82			
		August 18	2.06	2.06	1.80			
		August 20	1.39	1.28	1.50			
		August 22	1.35	1.50	1.61			
		August 24	1.39	1.28	1.50			
		Total . . .	13.62	15.78	14.33	14.58		
	3	Nov. 27	6.97	5.98	5.72		33.85	Paddies submerged and growing maturing rice
		Nov. 29	3.99	3.72	3.19			
		Dec. 1	3.22	3.15	2.69			
		Dec. 3	2.34	2.42	2.42			
		Dec. 5	2.49	2.42	2.53			
		Dec. 7	2.11	2.19	1.77			
		Total	21.12	19.88	18.32	19.77		
	4	Dec. 31	5.47	5.58	5.62		34.33	Paddies submerged and growing matured rice
		1921						
		Jan. 2	2.83	3.95	3.33			
		Jan. 4	2.41	2.64	2.64			
		Jan. 6	2.09	2.22	1.78			
		Jan. 8	1.97	2.12	1.97			
		Jan. 10	1.97	1.97	1.89			
		Total	14.74	18.48	17.23	16.82		

TABLE V.—*Summary table for Paddies A and B.*

Paddies	Set No	Soil conditions.	Date	Moisture.	CO_2 in 100 grams soil in 12 days. Average of three samples.	Total average of three samples.	NH_3-N average of eight samples.	Amino acid N Average of two samples	NO_3-N average of two samples	NH_3-N in terms of total N.	Amino acid N in terms of total N.
			1920	*per cent*	*mg.*	*per cent*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*per cent.*	*per cent.*
A	1	Paddies lying fallow	April 20	20.22	15.69	0.091	66.70	8.82	Not determined	7.329	0.969
A	2	After two days of heavy rain and while the paddies were still lying fallow.	May 10	31 95	41.44	0.100	26 25	8.39	Not determined	2.625	0.839
A	3	Paddies submerged and planted with rice	Nov. 9	41 86	23.92	0.184	14.30	9.01	none	0.777	0.489
A	4	Paddies submerged and rice maturing	Dec. 12	40 58	23.51	0 219	trace	10 72	none	———	0 498
B	1	After several rainy days. Soil had been plowed and was ready for planting	July 17	24 77	19.89	0 110	17 50	8 51	Not determined	1.591	0.774
B	2	Paddies growing rice about two weeks old. Soil drying and beginning to crack	Aug. 12	17.80	14 58	0 125	16.05	8 45	Not determined	1 284	0.677
B	3	Paddies submerged and growing maturing rice	Nov. 25	33.85	19 77	0 195	trace	9 12	none	———	0.466
B	4	Paddies submerged and growing matured rice	Dec. 29	34.33	16 82	0 209	3 40	9 45	none	0 166	0.462

INSECT CARRIERS OF *DIPLODIA* IN STORAGE-ROTS[1]

By VALERIANO M. SARMIENTO

INTRODUCTION

Dry rot caused by *Diplodia* is a common disease of stored agricultural crops. Its development is favored by improper storage conditions which allow access to certain agents of dissemination, coupled with the lack of care and undue handling of the material.

EXTENT OF DAMAGE RENDERED BY *Diplodia*

According to Reyes (1) this fungus and its allies are prevalent in this country and abroad attacking a great number of plants, including stored roots, seeds, and fruits. A fifty per cent loss of sweet potatoes in the College of Agriculture was estimated. It is reported that in the storage houses in the United States an annual loss in sweet potatoes amounts to several million dollars. Reyes (1) observed *Diplodia* sp. to cause great damage to *gabi* (taro), yautia, and yams; to roots of cassava; to stored mango, jackfruit, cacao, papaya, citron, and banana. It also infects egg-plant, soursop, squash, lima bean, cotton bolls and *ubi* (yam). A considerable loss of watermelons was observed in Washington, D. C. Harter[2] considers *Diplodia* to be the most destructive of all the storage-rots. Pole Evans[3] found it to affect all varieties of citrus in South Africa.

With an aim to reduce the great losses of stored products, or to make storing profitable, various studies have been made, but no end as yet has been attained owing to the wide scope of the problem involved. Fungi causing storage rots are numerous. They are disseminated by spores which are very small and light so that their spread is made easy through various agencies that come in contact with them. Several types of distribution have been found, such as pedestrians, pickers, or harvesters, animals, birds, insects, running water, wind, etc. Barrett and Burrill[4] demonstrated that spores of *Diplodia* could be blown by wind 350 yards from the infected ears of corn. Wolf (2) found that wind carries spores of *Cercospora personata* (B. & C.) C. He made no tests to determine how far they could be blown, but his exposures, eight feet from infected plants, showed their presence. Levin[5] showed that wind and water carry spores of *Septoria lycopersici* Speg. Martin (3) scraped the hands and garments of the tomato fruit-pickers to prove that they were carriers of *Septoria lycopersici* Speg., and *Alternaria solani* (E. &. M.) Jones and Grout.

The writer of this paper assumed that the insects found feeding or hibernating on stored crops attacked by *Diplodia* were carriers of the pathogene in some such way as are pedestrians, tomato-fruit pickers, or the insects that pollinate flowers with the pollen grains that adhere to their bodies.

[1] Thesis presented for graduation from the College of Agriculture, No. 150; Experiment Station contribution, No. 120.
[2] *Cited* by Reyes (1).
[3] *Cited* by Reyes (1).
[4] *Cited* by Martin (3).
[5] *Cited* by Martin (3).

This work was designed, therefore, to determine (a) what insects carry *Diplodia*, if they do, (b) how transmission of the fungus is accomplished by them, and finally (c) control measures deduced from the study.

This work was undertaken during the school years 1920-21 and 1921-22 at the College of Agriculture, Los Baños.

REVIEW OF LITERATURE

There were no reports on the transmission of *Diplodia* by insects in storage-rots previous to 1920 when Reyes (1) found that weevils disseminated the disease, but he was unable to prove this positively. Investigators, however, have found that insects act as carriers of pathogenes from infected to healthy plants.

Stevens (4) mentioned insects as one of the probable carriers of citrus canker. Reinking (5) attributed the responsibility of spread of coconut bud-rot to insects that bore holes on the stem just opposite the bud. Butler (6) observed that epidemics of red rot and rind disease of sugar cane often follow severe attacks of cane flies. Because the acervuli break through the cuticle exposing numerous spores, with the presence of white flies, Tisdale (7) believed these insects to be the carriers of *Melanconium* spores on tomatoes. Experimenting with tomato leaf-spot, Martin (3) concluded that some insects belonging to the families Sphingidae, Chrysomelidae, and Coccinellidae are carriers of spores of *Septoria lycopersici* Speg., and *Alternaria solani* (E. & M.) Jones and Grout., in their digestive systems and on their bodies.

In 1913 Stewart (8) reported that the tarnished plant bug, and in 1915, (9) the insects feeding upon the exuding sap from wounds made by hailstones on pear trees, are carriers of the fire-blight organism, *Bacillus amylovorus* (Burr.) De Toni. According to Stewart and Leonard (10) the sucking insects which puncture apple and pear seedlings, rather than the flies that make no injury, and according to Burrill (11) the aphids *Aphis avenae* Fab., and *Aphis mali* De G., are carriers of the fire-blight and are effective in causing infection. Hesler and Whetzel (12) stated that wasps, bees, flies, bugs, beetles, aphids, curculios, and leaf hoppers may carry the bacterial pathogene to the opening blossoms, tender twigs, and wounds in the bark of pear trees. Burrill (13) reported that pomace-flies transmit the bitter rot of apples, *Glomerella rufomaculans* (Berk.) S. & S. Gloyer and Fulton (14) arrived at the conclusion that the tree crickets on apple trees are not only carriers of *Leptosphaeria coniothyrium* (Fckl.) Sacc., from raspberries to apple trees, but also carry spores of other fungi.

Smith and Boncquet (15) found that *Eutettix tenella* Baker had no effect upon sugar beets, unless it had sucked diseased leaves and retained the juice for 24-28 hours, after which it efficiently produced the curly leaf. Pool and McKay (16) mentioned insects as carriers of *Phoma betae* (Oud.) Fr., and (17) showed later by plating that *Diacrisia virginica* Fab., *Monoxia juncticollis* Say., and *Loxostege sticticalis* L. (the webworm) are carriers of *Cercospora beticola* Sacc.

Rand (18) believed that the cucumber beetle, *Diabrotica vittata* F., is chiefly responsible for the dissemination of the wilt of cucurbits. From water in which twelve spotted beetles were washed, Carsner (19) succeeded in plating the angular leaf spot of cucumber in potato-dextrose-agar. Rand and Cash (20) found that *Bacillus tracheiphilus* E. F. Sm., the cause of cucumber wilt, gained entrance through the punctures made by *Diabrotica vittata* F., and *Dia-*

brotica 12-punctata Oliv. The excrements of these insects are also capable of producing infection.

At Big Rapids, Michigan, Doolittle (21), 1915, showed that *Aphis gossypii* Gl., transmitted the mosaic disease of cucumber from infected to healthy vines. In the same year in the vicinity of New York, Jagger (22) made a similar observation.

The co-operative project carried by the Bureau of Plant Industry, U. S. Department of Agriculture, and the Department of Plant Pathology, Agricultural Experiment Station, Maine, as reported by Folsom (23) resulted in the conclusion that aphids, or plant lice, are important agents in the transmission of potato mosaic. Because the flea-beetle attacks potato leaves, the host of the blight organism, Jones and Vaugan (24) states that it disseminates the pathogene. Recently, Morse (25) found that both the flea-beetle, *Epitrix cucumeris* Harris, and the pink and green aphids, *Macrosiphum solanifolii* Ash., were responsible for the dissemination of late blight of potatoes.

Wolf (2) found that grasshoppers are agents in the distribution of *Cercospora personata* (B. & C.) C., he also stated that digestion did no harm to the vitality of the spores. Other spores were found on the insects' bodies, such as *Puccinia cassipis*, *Alternaria* sp., *Fusarium* sp. *Helminthosporium* sp., and *Ravenelia* sp.

Experimenting with mosaic disease of sugar cane, corn, and other grasses, Brandes (26) concluded that *Aphis maydis* Fitch., transmits corn mosaic.

Jagger (27) demonstrated that *Myzus persici* Sulz. disseminates lettuce mosaic.

Allard (28) reported that *Myzus persici* Sulz., and the plant louse, *Macrosiphum tabaci* are efficient carriers of the mosaic disease of tobacco.

Certain insects under the orders Hemiptera, Coleoptera, Diptera, and Hymenoptera, as determined by Studhalter (29) are carriers of chestnut blight. Craighead (30) believed that the spores of this disease, gained entrance through wounds caused by cicadas, aphids, tree crickets and tree hoppers.

Regarding the spinach blight, McClintock and Smith (31) reported that aphids have to remain on the plant at least fourteen hours before they can efficiently cause infection.

From a series of experiments, Gravatt and Marshall (32) concluded that snails, slugs, weevils, and sowbugs were carriers of uredospores and sporidia of *Cronartium ribicola* F. de Wal. These spores adhere to the insects' bodies at least a week under certain conditions. Numerous aeciospores and uredospores were found on the bodies of the gipsy-moth's larvae, and because the Bureau of Entomology found that these larvae are carried by wind 20 miles, Gravatt and Posey (33) concluded that the blister-rust of pine trees is disseminated by the larvae. After further observation and experimentation with insects collected from *Ribes* bushes, Snell (34) stated that every insect may at times become a carrier of spores of *Cronartium ribicola* F. de Wal.

After reviewing the literature on insect transmission of plant and animal diseases, Rand and Pierce (35) made this statement, "The final criterion, then, should be the actual transmission of the disease under controlled conditions simulating as nearly as possible those found in nature".

MATERIALS AND METHODS

The available root crops during the progress of the work were tubers of cassava, *gabi* (taro), sweet potato, and citrus fruits.

INSECTS

The insects found associated with the root crops attacked by *Diplodia* spp. are presented in Table I. These groups of insects were observed to be the most abundant. There were, however, several others not here considered. Table I gives the insects, families to which they belong, and the hosts where they were most frequently found.

TABLE I.—*Insects found on stored seeds, roots, and fruits.*

Insect.	Family.	Host.
Araeocerus fasciculatus De Geer	Anthribidæ	cassava, eggplant, sweet potato, *tuge*, *ubi*, (yams), citrus, and *gabi* (taro)
Cylas formicarius (?) Fab.	Curculionidæ	sweet potato
Calandra oryzæ Linn.	Calandridæ	beans, rice, corn, *gabi* (taro), cassava, sweet potato, *ubi*, and *tuge* (yams)
Dinothrips sumatrensis Bag.	Phlœothripidæ	cassava
Musca domestica Linn.	Muscidæ	Any fermenting roots or fruits
Drosophila ampelophila Lœw.	Trypetidæ	Any fermenting roots or fruits
Carpophilus spp.	Nitidulidæ	cassava, papaya, *ubi*, *tuge* (yams), jack fruit, eggplant
Prometopia 4-maculata Mots.	Nitidulidæ	cassava, beans, and *gabi* (taro)
Undetermined	Nitidulidæ	cassava
Colobicus parilis Pasc.	Colydiidæ	cassava
Nerius fuscus Wied.	Micropezidæ	papaya, eggplant, cassava, *gabi* (taro)
Inopeplus sp.	Cucujidæ	

OBSERVATIONS

Observation was made on stored root crops in the seed laboratory of the College of Agriculture. Newly harvested and washed cassava tubers almost all rotted after a week, due to *Diplodia*. *Diplodia* was found very abundantly.

Just after washing and spraying the roots, the house and the fruit flies were noticed at once in great numbers. The wounds or bruises made in digging were frequented by the insects. After a day or two weevils and other insects were found. The insects increased day after day until the roots hardened and shrunk; many of the insects remained on this dried material. After ten days the fungus turned black most noticeably at the cracks or crevices of the bark.

Some similar cases were found on piles of eggplants and papayas. On sweet potato, rot occurred after twenty-one days. Still a longer period was observed in the case of *gabi* (taro), *ubi*, and *tuge* (yams). Numerous insects were found also.

The observations seemed to show that there must be a certain relationship between the insects and the pathogene which develops very rapidly after a visit of these pests.

INTRODUCTION OF INSECTS INTO CONFINEMENTS

Procedure.—Small glass jars about 14 centimeters in diameter and 19 centimeters high were sterilized. After heating and cooling the sand, it was placed in the jars, making a layer at the bottom 3 to 4 centimeters in thickness. Each jar was covered with a double of cheesecloth with a layer of cotton placed between to admit air but to exclude dirt or contamination. Three tubers were placed on top of the sand layer.

With a pair of flamed forceps, the insects, with the exception of the flies which were captured with a net, were picked up carefully one by one, put in a vial, brought into the laboratory and put into the prepared glass jars. At least ten insects, all collected from hosts infected with *Diplodia*, were put in each jar. For the results see "Experiments and Results."

EXAMINATION OF INSECTS UNDER MICROSCOPE

Procedure.—Insects were picked from diseased tubers with a flamed pair of forceps, put in a cyanide vial, and brought to the laboratory for observation with a 16 millimeter lens. Each insect was rolled in a drop of water on a clean slide to wash the spores from its body. The body and legs were then examined and the number of spores noted. The spores which were left in the drop of water were counted. See Table II for the results.

PLATING OF INSECTS IN POTATO-AGAR PLATES

Procedure.—Two, and sometimes four, insects were collected and plated in a potato-agar plate. They were left in the plate for an hour or two before they were removed. The plate was examined under a 16 millimeter lens and the spores were counted. In other plates a counting was made after twenty-four hours, when young mycelia had already appeared. Counting was made easy in this way, but the objection is that probably some spores did not germinate. The results are given in Table II.

Bits of mycelia from every kind of insect plated were put into six test tubes of potato-agar.

EXPERIMENTS AND RESULTS

INFECTION EXPERIMENTS

The same treatment and methods were used throughout these experiments. The insects were repeatedly tested, using the hosts where they were found most frequently and numerously. Table I shows the insects and hosts.

Each set of experiments consisted of twelve glass jars prepared, as explained above; one-half were moistened with sterilized water and the other half were left dry. Tubers or fruits placed on top of the layer of sand were slit with a flamed scalpel, except the ones already cut at one or both ends when fitted in the jars. Two jars from each of the dry and wet lots were made as controls. The insects collected from hosts infected with *Diplodia* were freed in the test jars.

Araeocerus fasciculatus De Geer.—Three tests were made with this insect, using sweet potato in the first two sets and cassava tubers in the third.

Set a.—The first test was started on November 15, 1920.

Result.—Of the dry lot, two tubers were diseased on December 15; no indication of the disease was observed in the wet lot. On December 20, five more tubers in the dry and two in the wet lot were diseased. Some moistened tubers sprouted. The diseased roots shriveled, hardened, and dried. Some insects died in all the lots. By the end of December, all the tubers in the dry jars were infected, except in one container where all the insects died. Of the twelve roots in the wet lot eight were diseased while the others sprouted. The controls remained healthy.

Set b.—Another set was started on December 10, 1920.

Result.—It was observed that on January 8, 1921, four tubers were attacked in the dry lot. No disease was observed in the wet jars. On January 20, four more in the dry lot rotted, and only three in the wet lot were infected. By the end of January all, save one tuber in the dry lot and five in the wet lot, were diseased.

Set c.—Cassava tubers were used in this test which was started on January 4, 1921.

Result.—Quick infection was observed in this test. Two tubers in the moist jars were attacked, one on January 8, and one on January 11; only two roots in the dry and four more in the wet lot rotted. On January 15, all the moist roots and a total of eight roots in the dry were diseased. In the control jars not a single tuber showed infection. The pathogene at first appeared as a cottony growth on the slits and cut ends of the tubers, turning black at the crevices and cracks of the bark of the roots after the eleventh day. The fungus developed rapidly in the moist jars.

Set d.—This test was conducted to check the only observation made in connection with citrus, i. e., the peelings of *Citrus decumana* Linn., which were infected with *Diplodia* accidentally. Many *Araeocerus fasciculatus* De Geer. were found associated with the disease.

This test was made in six glass jars, three of which were moistened and three left dry. One jar from each lot was made the control. Peelings of eight or ten fruits were put in the jars and insects collected were introduced into the confinements on January 22.

Result.—First infection was noted in the dry jars on February 4 and by February 6 the peelings in both dry jars were diseased. On February 18, both wet jars showed infection. Control cultures were healthy, although the dry peelings shriveled and turned hard.

Cylas formicarius (?) Fab., was used in three sets of experiments and exclusively with sweet potato roots.

Set a.—This test was started February 20, 1921.

Result.—On March 11, nineteen days after the introduction of the insects in the jars, infection was noted in the dry jars. The insects in both lots bored holes into the tubers. On March 15, all the dry jars were infected, and in the moist jars only one tuber showed infection. Tubers in the wet jars sprouted. On March 22, all tubers in the dry lot were infected and only two in the moist lot. Insects increased about the end of March and no more infection was observed in the moist jars. The insects aided the fungus in the destruction of the tubers. Upon breaking the tubers, the tissues were black. Larvae and newly emerged adults were found in the tubers.

Set b.—The second test was started on March 1.

Result.—On March 22, the disease was noticed in a dry jar and in another one on March 24, on which date not one was yet infected in the moist lot. On April 4, all the tubers in the dry jars were diseased, while not one as yet showed the disease in the moist jars. On April 18, ten tubers were badly attacked in the dry lot, while only six in the wet jars showed the disease. The control jars were not infected. Insects increased in the test jars destroying the diseased and healthy tubers.

Set c.—The last test was started April 2. Another source of *Cylas formicarius* (?) Fab., was observed while digging sweet potato roots in an old plantation for experiments. It was observed that almost all the roots were destroyed by the insect, which was found associated with the tubers under the cracked ground. Out of curiosity a test was made with the insects collected from this plantation.

Result.—It was found that throughout April and May, both the dry and wet lots, including the controls were not infected. In all the jars where the insects were the roots were entirely destroyed by the increased number of insects after five weeks. This test shows a relationship between the insects and *Diplodia* sp.

Calandra oryzae Linn., was found in many hosts, but it was tested only with cassava, sweet potato, and *gabi* (taro). Four tests were made with it.

Set a.—The test was started May 2, with this insect confined with cassava tubers.

Result.—On May 6, infection of three tubers in the moist jar and one in the dry was noticed. On May 8, all the tubers of both lots, save one in the dry jar, were infected. In one of the wet jars was observed a soft rot caused by bacteria, characterized by a yellowish, watery, soft area. Control tubers remained healthy.

Set b.—This test was started May 16, using cassava tubers in eight jars. One jar from each lot was put aside for control.

Result.—A noticeable infection started in the wet lot on May 19, and on May 20, the dry lot showed the disease. Finally, on May 25, all tubers in both lots were attacked; the controls remained healthy.

Set c.—The third experiment was started June 2, with eight glass jars of *gabi* (taro). Two jars, one dry and one wet, were left as control.

Result.—On June 20, two tubers in the wet jars and two more on June 25, were infected, on which date only two roots in the dry jars were attacked. The fungus showed slow development on this host. By the end of the month it was found that only two in the dry and five in the moistened jars had rotted. No fungus growth was found in the control jars.

Set d.—The test was arranged and started on May 25. Insects were collected from a bunch of corn ears and beans. Only six jars of sweet potato tubers were used.

Result.—The experiment was left till the end of June and no infection was noticed whatever. Many of the insects died. Some of the moistened tubers sprouted. That no infection occurred was probably because no spores of *Diplodia* were carried by the insects—being collected from hosts showing no disease.

Colobicus parilis Pasc., was scarce. However, two tests were made with it, consisting of six glass jars to each set. The host used was cassava.

Set a.—The first experiment with this insect was started June 20.

Result.—On June 24, infection was noticed in the wet lot, and the disease appeared on June 25 in one of the dry jars. All the moistened roots were attacked on June 27, on which date the fungus began to turn black. All the tubers in the dry lot rotted.

Set b.—The second test was started July 2.

Result.—After four days the wet lot showed infection and two days later the disease was noted in the dry jars. Control jars remained uninfected. On July 11, the total number of diseased tubers was six in the wet and four in the dry lot. More tests with this insect were not possible because of its disappearance.

Carpophilus spp., was found on rotting papaya fruits in the field infected with *Phytophthora* and *Diplodia*, on rotting eggplant, cassava, sweet potato, *gabi* (taro), and *ubi* (yam). Because cassava was found very susceptible to *Diplodia* it was exclusively used in the three tests with *Carpophilus* spp.

Set a.—The first test was started July 15.

Result.—The first infection was noted on July 18 in the moist lot, and on July 21 the dry lot showed the disease. On July 28, all the tubers in the moistened jars and a total number of six in the dry jars were infected. Some tubers were entirely covered with the fungus in the moist jars. In the dry lot *Rhizopus* sp. and bacteria were noted.

Set b.—The second experiment was started August 1, with six glass jars of cassava.

Result.—Rapid infection took place in both lots, starting on August 5. On August 10, all tubers were diseased in both lots. Control tubers remained healthy.

Set c.—This test was started August 6.

Result.—On August 9, the wet lot was infected, and had advanced until August 11, when the dry lot showed infection. On August 15, all tubers in both lots rotted. Controls remained uninfected. The characteristic fungus growth was observed in all three sets made.

Promotopia 4-maculata Mots., was very scarce, but an effort was made to secure a 6-glass-jar test. Cassava roots were used. Two controls were made, one from each lot. The test was started on October 25, 1920.

Result.—Both lots were infected on October 31, and on November 5, all the wet-lot tubers were attacked, and only four in the dry jars showed the disease. The test was renewed and the tubers were examined. The inside portion of the roots turned black with black fruiting bodies of the fungus on the cracks and crevices of the bark. The control tubers were partly dried but no fungus attack was observed.

Musca domestica Linn., ***and Drosophila ampelophila*** Loew., were collected with a net, so that the tests made with them cannot be relied upon. From the net the insects were put in a small vial and were brought to the laboratory. They were then freed in the prepared confinements.

The set with the house fly was started on November 10, 1920. Cassava tubers were used in twelve glass jars.

Result.—Rapid infection occurred in the wet jars, and was observed on November 15. On November 18, few insects survived in the dry jars, but infection was noticeable. Examining the jars on November 25, only three tubers in the dry lot and ten roots in the moist lot were badly diseased. The controls were not affected.

The set with the fruit fly was started on November 10, 1920. Cassava tubers in twelve glass jars were employed.

Result.—After three days the wet lot showed the disease. On November 20, bacterial infection was observed in the dry lot, three roots being attacked by *Diplodia*. In all, five in the wet jars and three in the dry lot were diseased. Many insects died in the dry jars and some in the wet. Control tubers remained undiseased.

Nerius fuscus Wied., ***Dinothrips sumatrensis*** Bag., ***Inopeplus*** sp., and the undetermined Nitidulidae.

There were too few of these insects to allow an entire experiment. It was also noted that when the chance of testing them came, it was just the time when they disappeared. Notwithstanding their scarcity, quite a number of each group was collected for examination for spores on their bodies, the result of which follows under a separate heading.

MICROSCOPIC EXAMINATION OF INSECTS FOR SPORES OF DIPLODIA ON THEIR BODIES

This study was made to find out whether the insects already tested carry spores of *Diplodia* on the outside of their bodies. Insects were collected at different dates from hosts infected with *Diplodia*, such as cassava, sweet potato, *ubi* (yam), *gabi* (taro). Upon putting an insect on the slide with a drop of water the spores were easily washed out. In many cases spores were found on the hairy legs, wings, antennae, and the abdomen.

TABLE II.—*Result of examination of insects under microscope.*

No.	Insect.	No. of insects examined.	No. of spores.	No. of insects carrying no spores.	Average number of spores for each insect.
1	*Aræocerus fasciculatus* De Geer.	34	430	—	12.64
2	*Cylas formicarius* (?) Fab.	25	244	—	9.75
3	*Calandra oryzæ* Linn.	31	306	2	9.87
4	*Colobicus parilis* Pasc.	28	235	5	8.39
5	*Carpophilus* spp.	41	242	2	5.9
6	*Promotopia 4-maculata* Mots.	30	110	8	3.66
7	*Musca domestica* Linn.	22	45	9	2.04
8	*Drosophila ampelophila* Lœw.	35	35	12	1.00
9	*Nerius fuscus* Wied.	10	9	4	0.90
10	*Dinothrips sumatrensis* Bag.	21	50	5	2.85
11	*Inopeplus* sp.	10	15	5	1.5
12	Undetermined (Nitidulidæ)	16	25	2	1.56

From Table II it appears that all the insects examined under *Araeocerus fasciculatus* De Geer., and *Cylas formicarius* (?) Fab., were carriers of spores of *Diplodia*. Some individuals of the other groups were found harboring no spores.

The first six groups in the list were carriers of many spores, while the last six carried with them only a small number easily noticeable.

Putting the average in round numbers, every *Araeocerus fasciculatus* De Geer., carried 13 spores, and therefore, appears to be the most dangerous of all the insects studied. Each of the *Carpophilus* spp., *Colobicus parilis* Pasc., *Calandra oryzae* Linn., and *Cylas formicarius* (?) Fab., carried from six to ten spores, while each of the others carried from 1 to 4 spores. This result reveals the fact that the insects associated with the stored root crops attacked by *Diplodia* were carriers of the pathogene.

PLATING EXPERIMENTS

To be more certain of the many spores found on the bodies of insects examined, some of them were plated in potato-agar. The procedure followed was briefly described under "Materials and Methods". The results of the tests made are found in Table III.

TABLE III.—*Result of plating the insects in potato-agar.*

No.	Insect.	No of plates	No. of insects	No. of spores.	Average number of spores.
1	*Araeocerus fasciculatus* De Gerr.	6	18	199	11
2	*Cylas formicarius* (?) Fab. .	4	10	95	9 5
3	*Calandra oryzæ* Linn.	6	13	142	10.9
4	*Colobicus parilis* Pasc.	4	8	62	7.75
5	*Carpophilus* spp.	7	20	113	5.6
6	*Promotopia 4-maculata* Mots.	3	9	46	5.1
7	*Musca domestica* Linn.	3	6	20	3.33
8	*Drosophila ampelophila* Lœw.	5	10	18	1.8
9	*Nerius fuscus* Wied.	4	8	15	1.87
10	*Dinothrips sumatrensis* Bag.	3	6	30	5.0
11	*Inopeplus* sp.	4	10	27	2.7
12	Undetermined (Nitidulidæ)...........	3	9	21	2.3

The spores were counted twenty-four hours from the time that the plates were made. The young mycelia were then observable with the naked eye and counting was easy. Sometimes, however, counting was done just after the removal of the insects from the plates, that is, after one to two hours. The young mycelia were found along the footprints of the insects. Together with *Diplodia* spores, some bacteria and *Rhizopus* spores were noticed.

From Table III it will be seen that a great number of spores of *Diplodia* were carried by the insects introduced into the plates. Every one in the groups of *Araeocerus fasciculatus* De Geer., and *Calandra oryzae* Linn., was found a carrier of spores, in round numbers eleven, while *Cylas formicarius* (?) Fab., and *Colobicus parilis* Pasc., each carried ten and eight spores respectively. The groups

Carpophilus spp., *Promotopia 4-maculata* Mots., *Dinothrips sumatrensis* Bag., averaged five to six spores, and the rest from two to four spores each.

These figures point out that the insects were apparently carriers of *Diplodia* spores, and confirmed the result of the microscopic examination just presented. Evidently the spores adhere to the insects' hairy bodies, and fall freely with their movements, through which means occur the infection of the root crops, tested under controlled conditions.

CULTURE OF FUNGUS FROM SPORES SHED BY INSECTS

A pure culture of *Diplodia* was obtained from stored cassava tubers. Along with this culture, for comparison, transfers were made from the young mycelia in the potato-agar plates where the insects were allowed to move around. A separate culture was made with every kind of insect tested. It was observed that the characteristic growth of the fungus was the same in all the cultures. From microscopic examination, spores appeared to be the same as those in the pure culture as to color, size, form, and septation. This shows that the young mycelia in the potato-agar plates were evidently from the spores of *Diplodia* brought by the insects.

DISCUSSION OF RESULTS

Of the twelve species of insects collected only eight were used in the infection experiments. Infection took place most readily upon the slits made at the ends of the tubers cut with a scalpel when they were being fitted in the containers.

From Table IV, it appears that all of the following insects were carriers: *Araeocerus fasciculatus* De Geer., *Cylas formicarius* (?) Fab., *Calandra oryzae* Linn., *Colobicus parilis* Pasc., and *Carpophilus* spp. These five, including the common flies, were found most frequently and abundantly on stored crops.

It will be noticed that rapid infection took place in all the tests with cassava. The length of time before infection varied with the insects and with the root crops used. Cassava was infected after 3-7 days from the time the insects were freed in the confinements, citrus was attacked after 13 days, *gabi* (taro) after 19 days, sweet potato after 19-30 days.

It will also be noted that first infection occurred always in the moist lot except in the case of sweet potato and citrus. There were more tubers diseased in the wet lots, with the exception of the sweet potato tests, where the dry jars contained more infected roots. Moistened sweet potato tubers sprouted and kept longer.

In the test with *Calandra oryzae* Linn., and *Cylas formicarius* (?) Fab., when they were collected from the hosts free from *Diplodia*, no infection was observed. This freedom from infection indicates that spores of *Diplodia* were not carried by them.

Out of 48 sweet potato roots confined with *Araeocerus fasciculatus* De Geer., 35 were infected, and out of 24 cassava tubers 20 were diseased. The citrus peelings were also attacked.

With *Cylas formicarius* (?) Fab., collected from diseased hosts, out of 48 sweet potatoes, 30 rotted.

Of the 42 cassava tubers tested with *Calandra oryzae* Linn., 41 were infected, and 7 *gabi* (taro) tubers out of 18 tested were diseased.

The total number of cassava tubers infected through the agency of *Colobicus parilis* Pasc., was 22 out of 24 tested; probably all would have been diseased had the test been prolonged.

With *Carpophilus* spp., 42 out of 48 cassava tubers rotted.

There were 10 infected roots of cassava brought about by *Promotopia 4-maculata* Mots., out of 12 in the lots.

With the flies, the house fly caused 13 tested cassava tubers out of 24 to rot and the fruit flies infected 8 out of 24.

With all these tests no disease was observed in all the control tubers in the dry or wet lots, while in the case of sweet potato, moistened tubers sprouted and the dry ones shrank and were soft and tough to the touch.

In the examination of the bodies of the insects a great number of spores were observed on the hairy legs, antennae, and wings. From Table II, it appears that not a single insect under the groups *Araeocerus fasciculatus* De Geer., and *Cylas formicarius* (?) Fab., was observed not to carry spores. These two insects and *Calandra oryzae* Linn., *Colibicus parilis* Pasc., *Carpophilus* spp. and *Promotopia 4-maculata* Mots., were carriers of many spores, and except *Promotopia 4-maculata* Mots., were the most efficient in causing infection. Some of the other groups were observed not to carry spores. In spite of this, although the number of spores found was small, they caused infection in the tests made with them.

The spores clinging on the insects' bodies fall off easily. Since the flies were captured with a net, few spores were observed on them under the microscope.

By plating the insects, colonies of *Diplodia* sp., bacteria and other fungi were found along the footprints of the insects. From Table III, the recorded number of young mycelia is sufficient to supplement the examination of insects which aimed to prove why the insects were infective when tested with sound roots. From the plating test it was shown how easily the spores fall with the movement of the insects and how easily the spores germinate after twenty-four hours. This explains the rapid rotting of the stored root crops, especially cassava. Because bacterial colonies were observed in the agar plates, the bacterial infection in the cases of the fruit fly, the rice weevil, *Calandra oryzae* Linn., and *Carpophilus* spp., is to be expected although the infection may be of a secondary nature. It has, nevertheless, manifested itself to be a wet rot carried by the insects.

SUMMARY AND CONCLUSIONS

1. *Diplodia* sp. causes a dry-rot on stored crops. It may be disseminated in various ways like other plant diseases. Barrett and Burrill found that it could be blown by wind 350 yards from an infected ear of corn.

2. Insects were found to disseminate the *Diplodia* spores.

3. Insects found carrying spores belong to the families: Anthribidae, Calandridae, Cucujidae, Colydiidae, Curculionidae, Muscidae, Micropezidae, Nitidulidae, Phloeothripidae, and Trypetidae (Table I).

4. Of the twelve kinds of insects collected, *Araeocerus fasciculatus* De Geer., *Cylas formicarius* (?) Fab., *Calandra oryzae* Linn., *Colobicus parilis* Pasc., *Carpophilus* spp., and the two common flies were the most abundant groups on stored

roots and fruits. These, including *Promotopia 4-maculata* Mots., were all found capable of producing infection upon sweet potato, *gabi* (taro), cassava and citrus.

5. All the insects examined were carriers of spores which easily fall with their movements.

6. Not only *Diplodia* spores were carried by the insects but also bacteria and spores of other fungi.

7. Provided that the insects come across *Diplodia* infection they become carriers of the spores, as shown by *Calandra oryzae* Linn., and *Cylas formicarius* (?) Fab., where they caused no infection.

8. From the literature reviewed, insects were found carriers of spores of plant pathogene through their digestive systems and on the outside of their bodies. *Diplodia* was found carried by insects outside the bodies, especially on the hairy legs, antennae, etc.

9. Moisture made the sweet potato tubers resistant to the attack of *Diplodia*.

10. In the case of cassava, disease developed after three days with the insects.

11. Infection was first observed upon the cuts and bruises of the roots.

12. The insects were found to feed upon the roots, breed in them, and disseminate the pathogene.

RECOMMENDATIONS

1. The most effective measures to exclude these insects is by marketing agricultural products after harvest, or by keeping them in bins and barrels disinfected with formaldehyde (3 pints to 50 gallons of water), so that the insects cannot gain access.

2. *Calandra oryzae* Linn., prefers dark places; sunlight will then prevent its presence according to Kellogg (36) who further says that fumigation with carbon bisulfide will kill the pest in air-tight boxes. Fumigation most likely will be efficient against all the insects found on stored crops.

3. Injured tubers must be kept separate in storing, as the bruises or wounds are the spots frequented by the insects carrying the disease.

4. Diseased tubers should be thrown away, burned or buried in the ground as soon as detected, so that the insects may have a smaller chance of contact.

5. Sweet potatoes should be stored in a moist place; *gabi* (taro), cassava and citrus in well ventilated places.

6. Properly screened storage places will exclude all the insects that carry the spores.

ACKNOWLEDGMENT

To Prof. Otto A. Reinking and to Prof. Colin G. Welles of the Department of Plant Pathology, the writer wishes to acknowledge his indebtedness for advice and encouragement during the progress of this work. Thanks are also due to Prof. H. E. Woodworth, of the Entomology Department, for identifying the insects.

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TABLE IV.—*Summarized results of the infection experiments.*

Insect.	Set.	Materials tested.	No. of tubers tested.	Date begun.	First infection.		Final observation.			Remarks.
					Date.	Lot.	Date.	No. of diseased tubers. Lots.		
								Dry.	Wet.	
Aræcocerus fasciculatus De Geer.	a	sweet potato	24	November 15	December 15	Dry	December 31	9	8	Insects died in 1 dry jar
	b	sweet potato	24	December 10	January 8	Dry	January 30	11	7	
	c	cassava	24	January 4	January 8	Wet	January 15	8	12	
	d	citrus	Peelings	January 22	February 4	Dry	February 18	Both infected		
Cylas formicarius (?) Fab.	a	sweet potato	24	February 20	March 11	Dry	March 22	12	2	Some tubers sprouted
	b	sweet potato	24	March 1	March 22	Dry	April 18	10	6	Insects destroyed some tubers
	c	sweet potato	24	April 2	——		May 30	No infection		Insects from field
Calandra oryzæ Linn.	a	cassava	24	May 2	May 6	Both	May 8	11	12	Soft rot in wet lot
	b	cassava	18	May 16	May 19	Wet	May 25	9	9	
	c	*gabi* (taro)	18	June 2	June 20	Wet	June 30	2	5	
	d	sweet potato	12	May 25	——		June 30	No infection		Insects from corn and beans
Colobicus parilis Pasc.	a	cassava	12	June 20	June 24	Wet	June 30	6	6	
	b	cassava	12	July 2	July 6	Wet	July 11	4	6	
Carpophilus spp.	a	cassava	24	July 16	July 18	Wet	July 30	6	12	Bacteria and other fungi noted
	b	cassava	12	August 1	August 5	Both	August 10	6	6	
	c	cassava	12	August 6	August 9	Wet	August 15	6	6	
Promotopia 4-maculata Mots.	a	cassava	12	Oct. 25, 1920	Oct. 31, 1920	Both	Nov. 5, 1920	4	6	
Musca domestica Linn.	a	cassava	24	Nov. 10, 1920	Nov. 15, 1920	Wet	Nov. 25, 1920	3	10	Most insects died (dry)
Drosophila ampelophila Lœw.	a	cassava	24	Nov. 10, 1920	Nov. 13, 1920	Wet	Nov. 20, 1920	3	5	Bacterial infection (dry)

THE MOSAIC SITUATION[1]

By Frank P. McWhorter
Of the Department of Plant Pathology

Cane mosaic is so serious in the Philippine Islands that the newspapers run headline articles on the subject, and perhaps for this reason the word "Mosaic" is thought to refer particularly to a disease of sugar cane. However, this is not the only crop subject to the disease for it seriously affects maize, tobacco, tomatoes, and many other crops. Indeed, plants belonging to as many as twenty different families are subject to it. This paper is presented as a more or less popular review of recent important work on the subject.

Mosaic diseases have certain symptoms in common, no matter what the host. These symptoms are:

1. Mottled leaves: the spots look as though they had been soaked in water. This condition is best seen in reflected light.

2. General dwarfing of the plant.

3. Curling of the edges of the leaves in tender-leaved plants.

These three symptoms may be present at the same time. Unless No. 1 is present the disease cannot be conclusively diagnosed as mosaic.

The disease should not be confused with albescence, a term used in describing yellow and green spotted leaves such as those produced by the San Francisco plant *Codiaeum variegatum*. Such mottling is not generally considered a disease but a natural inherited character.[2] Another condition of whitened leaves with which mosaic should not be confused is chlorosis which condition is brought about by the deficiency of some element in the soil.

For mosaic in general we know a few unquestioned facts that are of value in understanding the disease. The more important of these are:

1. That if the juice of a mosaic diseased plant is inoculated into a healthy plant of the same species, the latter plant may become diseased. In other words, something capable of producing the disease is present in juice extracted from the plant.

2. That a substance present in the juice, and having the power of producing the disease, is of such extremely small size that it will pass through very fine filters, such a substance being known as a filterable virus. But the fact that there is a filterable virus present by no means proves that there is not a definite causal organism. From what does the virus come? Some filterable viruses are self-perpetuating.

3. That insects, chiefly aphids, are able to transmit the disease from one plant to another.

4. That many mosaics, notably bean mosaics, are inheritable—that is, carried over in the seed.

[1] Experiment Station Contribution No. 121.

[2] It may yet be shown that albescence results from a symbiotic mixture of host and parasite that is transmitted from seed to seed; mosaic can be inherited.

5. That cuttings from diseased plants are almost certain to reproduce the disease. This fact, of course, is important in accounting for the distribution of cane mosaic throughout the Philippines.

These are the generally accepted facts; what causes mosaic is the important and much discussed question.

Kunkel and Matz have described "foreign bodies" in the pith cells of mosaic-diseased maize and cane respectively. These bodies are hard to see and require very careful work for their demonstration. It is by no means certain that these bodies are living organisms. Such bodies, in the case of maize, are not present in healthy maize, but the writer has demonstrated in healthy cane bodies similar to those described by Matz. As yet there is little proof that these cause the disease; they are possibly the result of the disease.

Since mosaic may be regarded as a disease of the mal-nutrition type one would expect the internal seat of the trouble to lie in the phloem, the tissue that is most important in distributing food throughout the plant. Ray Nelson (1), whose recent paper I wish to review in detail, decided for two reasons that the real cause of the trouble must lie in the phloem. Briefly these reasons were: (a) In potato leaf-roll, a disease closely allied with mosaic, the phloem is partially destroyed. (b) That aphids, which are the chief agents for spreading the disease, extract their food largely from the phloem. His exact statement is. "The feeding habits of these insects offer valuable evidence as to the probable nature and location of the causal organisms. Those species known to transmit these diseases take their food material from the phloem tissues of the host plants, and after feeding for some time upon the veins and parts of the plants close to the phloem they are capable of transmitting the disease to healthy plants. Other species which do not attack the food-conducting tissues have not been shown consistently to be carriers of the infectious agents". He does not give his proof of the statement, but in the case of sugar cane, Brandes (2) backs him up most excellently. He (Brandes) was able to section aphids feeding on cane leaves and in his paper presents micro-photographs showing the beaks of the insects in place in the phloem region of sugar cane leaves. Seeking for the causal organism in the phloem region of mosaic diseased leaves Nelson got startling results. He demonstrated the presence of protozoa which apparently belong to the order Flagellata. These organisms are very different from the amoeba protozoan described by the writer as the probable cause of Fiji disease.[3] Nelson investigated several mosaic hosts and found protozoa of two types as follows:

Type 1. The type in bean and clover mosaic. This he calls the Leptomonas type. The protozoan there found is a tiny one-celled animal, motile by means of two flagella. He demonstrated the protozoa by means of stained sections and by direct examination of fresh, unstained sections. With a magnification of approximately 400 times they could be seen rapidly moving in the phloem cells. He considers them to be of the Leptomonas type because they are somewhat similar to protozoa that have been described by Lafont and others in the latex (milk tubes) of the Euphorbiaceae. In regard to their causing mosaic, he gives two statements which are strong evidence but not conclusive proof. They are, (a) that protozoa are not present in healthy bean and clover plants, and (b) that

[3] McWhorter, Frank P The nature of the organism found in the Fiji galls of sugar cane. The Philippine Agriculturist 11: 103-111 *Pls. 1-2.*

the same kind of protozoa are found in diseased plants of both bean and clover which is very suggestive since it has been proven that bean can be infected with clover mosaic and clover with bean mosaic. This second statement is further emphasized by the fact that tomato, in which he found a different kind of protozoan, cannot be infected with the mosaic of bean or clover.

Type 2. The tomato mosaic and potato (leaf-roll) type. In the phloem of mosaic diseased tomatoes, and of potatoes diseased with leaf roll, (a closely related disease), he found protozoa resembling trypanosomes. Trypanosomes are one-celled animals that move by means of an undulating flap-like membrane; in man and other animals they cause many serious diseases, such as sleeping sickness, surra, douraine, etc. These trypanosome-like protozoa were not present in healthy plants of either species. He points out that certain trypanosomes, notably *Trypanosoma brucei*, which causes the horse disease known as "nagana" throw off from their bodies tiny particles capable of producing the disease, hence the trypanosomes may prove to be the source of the filterable viruses known to be present.

From the work of Nelson we have the first really tangible cause of mosaic but much investigation has yet to be done before actual proof can be given that any mosaic disease is due to a protozoan. His paper gives convincing proof that protozoa are present in certain mosaic diseased plants.

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NOTE ON POISONING OF FOWLS BY *PASSIFLORA FOETIDA*[1]

By D. A. Herbert
Of the Department of Plant Physiology

Passiflora foetida is a tropical American vine naturalized in the Philippines and fairly common around Los Baños. In parts of the Islands it is used as a cover crop in coconut plantations. It smothers the weeds and when the coconuts have attained a certain height cattle are turned in and the vine eaten and trampled down.

Specimens of this plant in the flowering stage were submitted for identification by Dr. Miguel Manresa of the College of Veterinary Science in the first week of June. A number of fowls had died from eating the plants on Faculty Hill and five sick ones had been forwarded to the College for treatment. Examination of the material submitted showed that it had a high prussic acid content and to this the poisoning was undoubtedly due. Pammel in his *Manual of poisonous plants* records the species as cyanophoric. This note is published as a piece of definite evidence of poisoning by *Passiflora foetida* and goes to show that cyanophoric plants, two lists of which have been published by this Department (1) (2), must be looked on with extreme suspicion. In this case we have a plant of recognized fodder value suddenly developing toxic properties. It is all the more dangerous because it is not liable to be suspected on account of its usual usefulness.

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[1] Experiment Station contribution No 122

COLLEGE AND ALUMNI NOTES

Dr. B. M. Gonzalez of the Department of Animal Husbandry has returned to the college after an absence of two years in America and Europe as a pensionado. He graduated from Johns Hopkins University in Febraury 1923 with the degree of Doctor of Science (in Hygiene) the subject of his thesis being "The chromosomal localization of five factors determining duration of life in *Drosophila melanogaster*." The degree was conferred in absentia, Doctor Gonzalez having left America for the Philippines via Europe on December 4, 1922. He stayed approximately two months in Germany taking informal lectures at the University of Halle-Wittenberg. He visited various Universities and other educational institutions in Germany, Belgium, France, England, Holland, and Spain, and the homes of the Jersey and Guernsey cattle, the Percheron horse, and the Berkshire pig. Embarking at Marseilles, he returned to the Islands on a French liner, and arrived in Manila on April 23, 1923.

The directory of the college of Agriculture Alumni Association has been published in Volume XI, Number I of this Journal. The members of the association are requested to help the Secretary to keep this directory up to date by reporting to him all changes of address.

Mr. Elayda, '15, President of the College of Agriculture Alumni Asociation has been advised by telegram from Mr. Marcelino Constantino, '16, of the early death of our friend and co-alumnus Filoteo Rodis, '22, of Indang, Cavite. He died on June 10, 1923, and the funeral services were held in his home town the following day. The association, through its Secretary, has sent a telegram of condolence to the parents of Mr. Rodis expressing its heartfelt regret for this untimely demise of one of its members.

On the night of May 19, 1923, Dr. and Mrs. B. M. Gonzalez were surprised at their home by a party headed by the staff of the Department of Animal Husbandry. The bunch moved to the Roxas Residence where dancing was indulged in till the wee hours of the morning. The party was graced by some of the members of the Makiling Ladies Club, and a number of young ladies from Los Baños and Lipa. This party was given on the occasion of the recent arrival of the family from abroad.

Dr. R. B. Espino in charge of the work on abaca and coconut at the College of Agriculture spent the summer vacation in Davao, making a brief survey of the abaca and coconut industries of the province. He is very much impressed by the conditions of abaca and some of the coconut haciendas there, and speaks very highly of the courtesy and hospitality of the Davao people in general and of the hacenderos in particular. He brought back to the College specimens of abaca and of coconuts. Some are to be studied and others are to be planted.

Dr. Espino believes that in five years the province of Davao will have about one million coconut trees in full bearing stage. He also reports that the abaca stripping machines are fast relieving men from the most difficult task of extraction of abaca fiber, but believes that the machines require further improvement with respect to cleanliness of the fiber produced and further elimination of employment of men.

Mr. Santiago Festin, '18, was a visitor in the College a few weeks ago. He was a deputy governor of Davao from 1917 to 1921. From 1921 to June 19, 1923, he worked as Technical Agricultural Assistant and Industrial Supervisor of the Bureau of Agriculture for all the settlement farm schools in that province. He resigned from this position to become principal teacher in the agricultural school in Odioñgan, Romblon, his home town.

Dr. Marcos A. Tubangui of the College of Veterinary Science was married to Miss Pacita del Rosario of Manila in June 2, 1923. They spent their honeymoon partly in the Sibul Springs, partly in Los Baños, and partly in Pampanga, the home province of Dr. Tubangui. Dr. Tubangui, in addition to his regular duties in the Veterinary College will now teach zoology to the agricultural students. Mrs. Tubangui, is a younger sister of Mrs. Sixto A. Francisco, a resident of Faculty Hill.

Dr. L. B. Uichanco, '15, of the Department of Entomology, was recently elected fellow of the American Association for Advancement of Science. He has been a member of that organization since 1921.

Mr. Amando Laparan, '14, is now stationed at Calamba, Laguna, as extension agent of the Bureau of Agriculture. His former headquarters were at Sta. Cruz, Laguna.

Mr. Severino S. Aquino, '22, resigned his position in the Entomology Department at the College of Agriculture in order to engage in farming at San Carlos, Pangasinan, his home town.

Messrs. Vito C. Rada and Felix S. Manipol, who had been students in this College in its earlier days, recently returned in order to continue their agricultural courses.

Mr. Gaudencio M. Reyes, '20, who is a scientific assistant in the Mycology Division of the Bureau of Science, Manila, is spending his leave of absence at this College where he is taking post-graduate work in Plant Pathology.

Dr. Valente E. Villegas, '13, of the Department of Animal Husbandry, will soon occupy his new house which is being erected on his own lot adjoining the College grounds.

One of the latest additions to the "June brides" on the Faculty Hill was brought about by the recent arrival of Dr. and Mrs. F. M. Fronda from their honeymoon trip spent in and around Manila. They were married in Bay, Laguna, on May 28, 1923. Mrs. Fronda was formerly Miss Elpidia P. Eusebio of Los Baños, Laguna. Dr. Fronda is a member of the class of 1919, and is at present an instructor in the College, and the Secretary of the College of Agriculture Alumni Association.

Mr. Alejo T. Taleon, '21, a graduate assistant in the Department of Animal Husbandry, spent a three-week vacation in Tigbawan, Iloilo, his home town. He recently returned to duty in the College.

Mr. Feliciano Reveche, '22, has been appointed graduate assistant in entomology. His work will be to help in the investigations on sugar cane insects which are being conducted by the Department of Entomology.

Gregorio M. Francisco, '17, is now managing his own farm and an additional 2255 hectare-farm for another landowner. He resides in Sta. Rosa, Nueva Ecija, and in his last letter, he says:

"I love the farm so much that I am devoting all my life to it. Tell our brother agriculturists that there are unbounded opportunities for every live farmer and especially for those who are not afraid to get their feet and hands soiled." May we ask him this question: "What opportunities are there for our *marca señoritas?*"

An Agronomy Seminar is held in the Agronomy building every Friday afternoon from four to five under the management of Dr. R. B. Espino. The first meeting was held on June 22, 1923. Prof. M. B. Raymundo talked on "The growing of rice in California" and Dr. N. B. Mendiola gave an interesting report on "Chico marcottage and some of its business aspects". Excellent refreshments were served by Mr. P. A. David, a member of the Agronomy Staff. The second meeting will be held in the same place and at the same hour on Friday, June 29. Dr. Espino will talk on "Some facts in abaca industry of Davao not hitherto reported". Mr. David will report on "Comparative merits of three varieties of coffee as grown under Los Baños conditions". Refreshments will be served. Professor Raymundo, Mr. Punzalan and Mr. L. Gonzalez will act as hosts.

On June 18, 1923, the Los Baños Chapter of the patriotic and academic brotherhood Rizal Center held its annual election with the following results

Brother R. B. Espino..........Supreme Noble.
Brother M. Manresa...........Second Noble
Brother P. Rodrigo............Third Noble

Brother A. Gordon.............Fourth Noble
Brother J. Juliano..............Fifth Noble
Brother L. Sanchez.............Chaplain
Brother G. Antenor-Cruz........Lecturer
Brother D. Divinagracia........Orator
Brother T. F. Novero..........Steward
Brother Z. Montemayor.........Brother Guard.

With the aim of keeping alive the spirit of brotherhood, the "live-wire" Fraters of the Los Baños Chapter of Rizal Center have held a series of "blow-outs" during the last few weeks. The last one was given in the home of Dr. and Mrs. Espino by brethren Manresa, Cendaña, Tan and Espino.

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A STUDY ON THE GERMINATION OF ABACA SEEDS[1]

By L. G. FERRER and R. B. ESPINO

The propagation of abaca by seeds is possible (1), though very little is yet known about conditions influencing the germination of the seeds (2) (3). With the object of obtaining some data on the subject a series of experiments on the germination of abaca seeds was carried out at the College of Agriculture during the college year 1922-23.

Seeds of three varieties of abaca were used in the experiments. All of them came from bunches of ripe abaca fruit and were freed from the pulp by rubbing. Care was taken not to injure the seeds, nor to mix varieties. Depending upon the nature of the experiment, the seeds were secured or prepared as follows:

(1) The seeds from one bunch of fruit were mixed together.

(2) The seeds from the different hands of each bunch of fruit were separately prepared, or extracted.

(3) The seeds from the different fingers on the different hands of each bunch of fruit were separately extracted.

Eight sets of experiments were made, some with a certain treatment for the seeds, others without. In all cases the seeds were ultimately sown in ordinary wooden germinating boxes, each containing a sufficient amount of sterilized garden soil kept constantly moist but never allowed to become saturated with water. The experiments were conducted in a place partly exposed to the sun, so that the drying conditions of the surroundings were never intense, nor was the place cold. The series of experiments made together with their respective results may be briefly stated as follows:

(1) *To find whether the formation and development of seeds depends upon self-pollination or upon cross-pollination.*

Thirty inflorescences, or hearts of abaca varieties Libuton and Itom, were bagged before the first bract on each heart opened. The tests were made in the Abaca Nursery of the College and in the Maquiling Abaca Plantation.

Not a single fruit developed and after two months the inflorescences shriveled and dried up. The results plainly show that the abaca plant (varieties Libuton and Itom) is cross-pollinated and that the formation and development of fertile seeds depend upon it. The production of self-fertilized, or inbred seeds cannot be expected.

[1] Thesis presented for graduation from the College of Agriculture, No. 151; Experiment Station contribution, No. 128.

(2) *To find the comparative germination of seeds from different bunches of fruit of one variety and of seeds of different varieties.*

Without any previous treatment the seeds were sown in the germinating boxes. The summary of the results as well as part of the details of the experiment are given in Table I.

(3) *To find the comparative rate and percentage of germination of seeds from the different "fingers" on the different "hands" of a bunch of fruit.*

Here again the seeds from the different fingers were sown without any previous treatment. More of the details of the technique together with the summary of results may be found in Table II.

(4) *To find the effects of drying the seeds upon the rate and percentage of germination.*

The plan of the experiments together with the summary of the results may be seen in Table III.

(5) *To find the effects on germination of soaking the seeds in water of different temperatures.*

Because of lack of seeds this experiment was performed in three sets. Water with 30°C. and 40°C. was tried first; 60°C. and 70°C. together; and 50°C., 80°C., and 100°C. were run at the same time. The summary of results is given in Table IV.

(6) *To find the effect on germination of soaking the seeds in certain inorganic acids.*

A general scheme of the experiment together with the summary of the data is shown in Table V.

(7) *To find the influence upon germination of passing the seeds through the alimentary canal of man and of some animals.*

Pieces of fruit with seeds in them were fed (a) to chickens, (b) to a monkey and, (c) to man. All of the seeds fed to the chickens were digested, but those which left the alimentary system of man and of the monkey were in perfect condition. When sown many of them germinated. The results from this experiment are summarized in Table VI.

(8) *To find the effect of delayed planting upon the rate and percentage of germination of seeds.*

Seeds of one variety of abaca were gathered, dried in the shade, mixed thoroughly, and stored in a large bottle. At monthly intervals, from June 6, 1922, till February 6 of the following year, a planting of 200 seeds was made. The bulk of the results from the experiment is not here given, but a summary is presented in Table VII.

SUMMARY OF RESULTS

(1) The failure of abaca plant (varieties Libuton and Itom) to produce seeds when very young inflorescences were bagged is a clear indication that the plant is cross-pollinated. The arrangement and the order of development of the pistillate and staminate flowers on an inflorescence make cross-pollination the only possibility.

(2) The seeds of abaca of the three varieties planted under ordinary conditions required from 11 to 24 days before they began to germinate. The germination period spread over a period of from 18 to 52 days. From 20 to 89 per

cent germination was obtained. The seeds obtained from the different hands on each bunch of fruit had about the same degree of viability, but those obtained from different bunches of fruit of one variety had different germinating power, (see Table I).

(3) The seeds from the three different bunches of fruit from one plant had different percentages of germination. Seeds from all the hands on each bunch of fruit were viable. There was not any direct correlation between percentage of sprouting and the seeds obtained from the different hands on each bunch. In some cases hand 1 or 2 had seeds more viable than those obtained from the other hands. But contradictory results were also obtained.

The degree of viability of the seeds does not depend upon the position of the fingers on each hand (Table II).

(4) Drying the seeds in the sun for 24, 48 or 72 hours caused a loss of vitality. The seeds planted immediately after removal from the fruit pulp, as well as those dried in the shade for 24 hours before planting, showed a certain degree of viability. A higher percentage of germination was obtained from the former than from the latter (see Table III).

(5) The seeds which were soaked in water with a temperature of 40°C. at different durations required from about 21 to 38 days before germination took place; 35 to 38 days for seeds soaked in water for 15 and 20 minutes, respectively; 22 was the approximate average of days before germination (see Table IV).

Soaking in water with a temperature of 40°C. caused abaca seeds to germinate from 2 to 5 days earlier than when the seeds were soaked in water with a temperature of 30°C. However, the percentage of germination was about the same in both cases (Table IV).

The seeds that were soaked for 5 minutes, 10 minutes, or 15 minutes in water with a temperature of 70°C. all failed to germinate. About 21 per cent germination was obtained when the seeds were soaked for 5 minutes in water with a temperature of 60°C. When soaked in the same water for 10 minutes the percentage of germination decreased to 16 (Table IV).

All the seeds that were soaked for different periods in water with a temperature of 80°C. or 100°C. seemed to have lost their viability (Table IV).

Cases were observed in which seeds of abaca sown in a germinating box required more than 100 days before they sprouted. An extreme case of 155 days was recorded (Table IV).

(6) The rate and percentage of germination of seeds previously soaked in various inorganic acids at different concentrations and durations were not constant. In fact, the percentage of success was extremely low, and there was not any material saving of time before germination (Table V).

(7) All the seeds fed to chickens were digested. Those fed to man had the highest percentage of germination and in much the shortest time. Although the seeds that passed the stomach of the monkey were not digested yet the percentage of germination was relatively low (Table VI).

(8) There are indications that the seeds of abaca may lose vitality about three months after harvesting the seeds (Table VII). However, seeds buried in the ground may remain alive for 155 days (Table IV).

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TABLE II.—*Summary of results obtained from an extensive test on the comparative rate and percentage of germination of seeds of abaca (Variety Libuton) from the different fingers on the different hands.*

	Bunch I.						Bunch II.							Bunch III.							
	Hands number.						Hands number.							Hands number.							
	1	2	3	4	5	6	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
Finger No. 1																					
Date of sowing	June 14, 1922						July 20, 1923							July 21, 1922							
Seeds sown	122	88	110	97	55	93	31	55	47	59	55	63	63	31	31	45	59	25	28	28	40
Days before germination	27	41	31	29	38	38	21	29	104	36	21	21	21	22	22	23	22	20	27	21	26
Days germinating	37	66	54	55	58	17	43	75	24	9	52	70	65	31	31	30	31	33	50	55	52
Seeds germinated	100	44	75	55	20	32	15	12	3	2	9	18	18	15	19	16	28	18	14	16	23
Per cent germination	82.0	50.0	68.2	56.7	36.4	34.4	48.4	21.8	6 4	3.4	16.4	28.6	28.6	48.4	61.3	35.6	47.5	72.0	50.0	57.1	57.5
Finger No. 2																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown	108	73	140	127	30	95	39	65	55	78	54	66	58	41	64	33	45	26	40	35	25
Days before germination	24	31	31	27	31	34	26	23	27	34	21	29	21	27	20	21	29	20	27	21	22
Days germinating	45	53	46	42	58	74	25	37	46	42	28	41	49	42	42	52	47	11	36	19	31
Seeds germinated	95	55	90	83	19	36	10	11	13	1	9	14	16	17	46	20	13	12	18	17	10
Per cent germination	88.0	75.3	64.3	65.4	63.3	37.9	25.6	16.9	23 6	.3	16 7	21.2	27.6	41.5	71.9	60.6	28.9	46.2	45.0	48.6	40.0
Finger No. 3																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown	118	91	134	199	56	97	67	56	75	72	60	41	32		53	36	46	48	48	33	20
Days before germination	25	31	31	25	29	40	23	23	26	38	21	29	21		20	23	26	20	28	21	22
Days germinating	42	53	48	41	52	29	57	45	36	17	52	39	46		24	49	32	44	44	43	36
Seeds germinated	93	60	121	78	30	19	11	11	22	4	22	9	13		21	20	25	29	24	24	13
Per cent germination	78.8	65.9	90.3	39 2	53.6	19.6	16.4	19.6	29 3	5.6	36.7	21 9	40.6		39.7	55.6	54.4	60.4	50.0	72.7	65.0
Finger No. 4																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown		47	136	111	27	89	45	56	51	70	62	54	53		83	23	50	31	21	42	20
Days before germination		27	29	31	38	40	21	32	30	45	58	39	34		21	35	22	20	25	21	20
Days germinating		74	35	25	70	69	42	25	39	30	15	23	27		44	28	39	41	26	30	55
Seeds germinated		35	113	55	19	40	14	11	12	4	3	8	4		55	4	36	13	8	16	8
Per cent germination		74.5	83.1	49.5	70 4	44.9	31.2	19 6	23.5	5.7	4 8	14.8	7.6		66 3	17.4	72.0	41.9	38.0	38.0	40.0
Finger No. 5																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown		122	116	122	53	109	38	61	77	92	17	53	42			40	60	21	34	39	23
Days before germination		24	29	33	31	40	30	74	43	30	27	30	43			26	24	26	29	29	26
Days germinating		64	33	48	49	12	43	17	14	32	14	43	1			35	40	18	11	48	1
Seeds germinated		84	107	61	16	29	11	3	3	7	2	14	1			15	32	7	6	18	1
Per cent germination		68.9	92 2	50.0	30.2	26.6	28.9	4.9	3.9	7.6	1.2	26.4	2.4			37.5	53.3	33.3	17.6	46.2	4.4
Finger No. 6																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown		60	98	94	60	74	6	75	49		63	53	60			25	48	28	40	32	24
Days before germination		31	29	27	34	37	60	29	0		73	30	31			29	22	24	29	25	26
Days germinating		48	35	51	45	23	31	63	0		25	68	55			33	27	35	43	30	10
Seeds germinated		16	75	41	33	23	3	13	0.		3	26	17			18	31	12	21	18	3
Per cent germination		26.7	76 5	43 6	55.0	31 1	50.0	17.3	0.		4.8	49 1	28 2			72.0	64.6	42.9	52.5	56.3	12.5
Finger No. 7																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown		55	78	114	45	51	2	92	72		52	55	41			21	34	29	23	31	25
Days before germination		25	35	31	34	37	30	23	37		58	30	28			96	40	24	22	21	22
Days germinating		59	40	49	26	16	1	42	2		21	48	32			1	60	31	18	23	31
Seeds germinated		35	52	61	27	18	1	6	2		3	19	11			1	8	7	2	19	12
Per cent germination		63.6	66.7	53.5	60 0	35.3	50 0	6.5	2.8		5 8	34.6	26 8			4.8	23 5	24.1	8.7	61.3	48.0
Finger No. 8																					
Date of sowing	June 14, 1923						July 20, 1922							July 21, 1922							
Seeds sown		100		73	61	84	58	59			22	50	27			26	33	21	16	31	34
Days before germination		27		29	38	37	21	23			41	21	50			29	21	24	37	20	22
Days germinating		39		43	70	71	39	25			32	42	14			43	43	24	34	33	23
Seeds germinated		90		31	34	40	22	5			4	12	2			12	28	17	3	23	23
Per cent germination		90.0		42.5	55 7	47 6	37.9	8.5			18 2	24.0	7.4			46.1	84.9	80.9	18.8	74.2	67.6
Finger No. 9																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown				83			67	74			52	45	43				50	29	17		
Days before germination				25			23	30			43	27	34				22	27	31		
Days germinating				42			41	43			30	20	36				18	13	22		
Seeds germinated				47			29	6			2	7	12				21	9	4		
Per cent germination				56.6			43.3	8.1			3.8	15.6	27.9				42.0	31.0	23.5		
Finger No. 10																					
Date of sowing	June 14, 1922						July 20, 1922							July 21, 1922							
Seeds sown							44	38			73	44	43				40		29		
Days before germination							25	23			50	34	23				22		31		
Days germinating							38	20			19	49	32				24		41		
Seeds germinated							10	16			2	9	5				14		10		
Per cent germination							22.7	42.1			2.7	20.5	11.6				35.0		34.5		
Finger No. 11																					
Date of sowing	June 14, 1923						July 20, 1922							July 21, 1922							
Seeds sown							58	88				61	50								
Days before germination							50	25				30	29								
Days germinating							24	52				56	49								
Seeds germinated							8	9				5	20								
Per cent germination							14.0	10.2				8 2	40 0								

TABLE III.—*Summary of results obtained from comparative germination of seeds of abaca (variety Libuton) as affected by the extent of drying.*

	Planted soon after removal from the fruit.	Seeds dried in the shade for 24 hours.	Dried in the sun for		
			24 hours.	48 hours.	72 hours.
Date of sowing	May 18, 1922	May 19, 1922	May 24, 1922	May 29, 1922	June 2, 1922
Seeds sown	200	200	200	200	200
Days before germination	45	57	——	——	——
Days germinating	103	68	——	——	——
Seeds germinated	40	13	——	——	——
Per cent germination	20	6.5	——	——	——

Table I.—*Summary of comparative germinating power of seeds obtained from different varieties of abaca.*

Variety: Libuton.

	Bunch I.				Bunch II.						Bunch III.					
	Hand number.				Hand number.						Hand number.					
	1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	6
Date of sowing	July 22, 1922				July 22, 1922						August 16, 1922					
Seeds sown	157	582	658	382	403	274	299	112	697	152	217	220	315	324	325	180
Days before germination	24	21	23	21	21	22	22	22	21	22	14	16	14	14	14	16
Days germinating	47	43	66	32	50	41	49	57	43	45	48	51	56	60	57	57
Seeds germinated	99	310	360	236	284	209	259	83	430	89	65	63	144	128	111	87
Per cent germination	63.1	53.3	54.7	61.8	70.5	76.3	86.6	74.1	61.7	58.6	29.9	28.6	45.7	39.5	34.2	48.3

	Bunch IV.						Bunch V.						
	Hand number.						Hand number.						
	1	2	3	4	5	6	1	2	3	4	5	6	7
Date of sowing	August 16, 1922						August 19, 1922						
Seeds sown	305	309	307	398	197	121	970	690	577	901	1000	459	638
Days before germination	17	12	16	11	11	13	18	19	18	19	19	17	17
Days germinating	54	74	54	59	60	75	67	65	57	55	55	66	66
Seeds germinated	62	71	104	115	68	70	247	213	206	317	315	180	225
Per cent germination	20.3	23.0	33.8	28.9	34.5	57.9	25.5	30.9	35.7	35.1	31.5	39.2	35.2

	Variety: Tañgoñgon.											Variety: Itom.							
	Bunch I.					Bunch II.						Bunch I.							
	Hand number.					Hand number.						Hand number.							
	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	6	7	8
Date of sowing	July 24, 1922					July 24, 1922						July 25, 1922							
Seeds sown	137	386	194	485	378	15	560	819	460	360	328	2511	2904	1276	2067	1745	1992	908	1935
Days before germination	21	20	19	19	19	19	19	19	19	19	19	22	20	19	20	19	19	19	19
Days germinating	41	29	30	29	29	26	47	18	47	30	37	52	51	30	44	45	33	30	28
Seeds germinated	112	232	130	179	205	173	349	223	138	214	144	1690	1185	1080	809	1009	694	369	763
Per cent germination	81.8	60.1	67.0	36.9	54.2	80.5	62.3	27.2	30.0	59.4	43.9	67.3	40.8	84.6	39.1	57.8	34.8	40.5	39.4

TABLE IV.—*Summary of results on the rate and percentage of germination of seeds of abaca (variety Libuton) soaked in water of different temperature for varying periods.*

	Variety: Libuton.												
	Temperature 30° C.												
	Durations of time soaking seeds in water.												
	1 min.	2 min.	3 min.	4 min.	5 min.	6 min.	7 min.	8 min.	9 min.	10 min.	12 min.	15 min.	20 min.
Date of sowing	August 12, 1922												
Seeds sown	200	200	200	200	200	200	200	200	200	200	200	200	200
Days before germination	28	28	28	25	25	25	23	27	25	27	22	23	27
Days germinating	59	56	41	58	61	31	46	25	44	44	54	60	25
Seeds germinated	40	25	21	23	32	42	40	15	39	30	42	22	28
Per cent germination	20	12.5	10.5	11.5	16.5	21.0	20.0	7.5	19.5	15.0	21.0	11.0	14.0

	Variety: Libuton.												
	Temperature 40° C.												
	Durations of time soaking seeds in water.												
	1 min.	2 min.	3 min.	4 min.	5 min.	6 min.	7 min.	8 min.	9 min.	10 min.	12 min.	15 min.	20 min.
Date of sowing	August 12, 1922												
Seeds sown	200	200	200	200	200	200	200	200	200	200	200	200	200
Days before germination	27	21	21	22	23	21	25	23	24	23	23	35	38
Days germinating	50	56	62	56	54	56	21	57	47	41	52	43	42
Seeds germinated	32	26	40	36	24	44	21	36	20	34	25	25	19
Per cent germination	16.0	13.0	20.0	18.0	12.0	22.0	10 5	18.0	10.0	17.0	12.5	12.5	9.5

	Variety: Libuton.												
	Temperature 50° C.												
	Durations of time soaking seeds in water.												
	1 min.	2 min.	3 min.	4 min.	5 min.	6 min.	7 min.	8 min.	9 min.	10 min.	12 min.	15 min.	20 min.
Date of sowing	May 19, 1922												
Seeds sown	200	200	200	200	200	200	200	200	200	200	200	200	200
Days before germination	155	88	91	87	88	94	117	87	83	116	105	871	120
Days germinating	84	79	102	59	94	97	72	101	48	36	7	51	1
Seeds germinated	7	10	12	15	15	8	9	3	8	2	2	3	1
Per cent germination	3.5	5.0	6.0	7.5	7.5	4.0	4.5	1.5	4.0	1.0	1.0	1.5	0.5

	Variety: Libuton.	
	Temperature 60° C.	
	Duration of time soaking seeds in water.	
	5 min.	10 min.
Date of sowing	Jan. 27, 1923	Jan. 27, 1923
Seeds sown	200	200
Days before germination	25	21
Days germinating	17	20
Sheets germinated	41	32
Per cent germination	20.5	32.0

NOTE:—Seeds treated for similar time periods, at 70°, 80° and 100° gave a germination percentage of nil.

TABLE V.—*Summary of results on the rate and percentage of germination of seeds of abaca (variety Libuton) as influenced by soaking in inorganic acids.*

	Variety: Libuton.									
	Sulphuric acid.									
	Concentrated.				6-normal.			3-normal.		
	½ hour.	1 hour.	2½ hours.	3 hours.	½ hour.	1 hour.	3 hours.	½ hour.	1 hour.	3 hours.
Seeds sown	200	200	200	200	200	200	200	200	200	200
Days before germination.	32	23	26	25	21	26	48	23	30	30
Days germinating	23	50	1	15	54	48	15	59	75	43
Seeds germinated	5	15	1	2	30	23	7	40	24	7
Per cent germination	2.5	7.5	0.5	1.0	15.0	11.5	3.5	20.0	12.0	3.5

	Nitric acid.									
	Concentrated.				6-normal.			3-normal.		
	½ hour.	1 hour.	2½ hours.	3 hours.	½ hour.	1 hour.	3 hours.	½ hour.	1 hour.	3 hours.
Seeds sown	200	200	200	200	200	200	200	200	200	200
Days before germination.	83	—	80	—	24	21	55	21	21	30
Days germinating	32	—	1	—	68	62	15	54	84	41
Seeds germinated	2	—	1	—	44	42	3	42	57	23
Per cent germination	1.0	—	0.5	—	22.0	21.0	1.5	21.0	28.5	11.5

	Hydrochloric acid.									
	Concentrated.				6-normal.			3-normal.		
	½ hour.	1 hour.	2½ hours.	3 hours.	½ hour.	1 hour.	3 hours.	½ hour.	1 hour.	3 hours.
Seeds sown	200	200	200	200	200	200	200	200	200	200
Days before germination.	125	72	35	—	25	21	48	21	21	48
Days germinating	1	1	1	—	58	61	23	49	59	15
Seeds germinated	1	1	1	—	34	26	19	43	30	27
Per cent germination	0.5	0.5	0.5	—	17.0	13.0	9.5	21.5	15.0	13.5

TABLE VI.—*Summary of results on rate and percentage of germination of seeds of abaca as influenced by passing through the alimentary canal of man and some animals.*

	(1) Variety: Libuton.						(2) Variety: Itom.		
	Fruit fed to chickens. [a]	Seeds passing through the alimentary canal of man.		Fruit with seeds fed to monkey.		Seeds without treatment.	Seeds passing through the alimentary canal of man.		Fruit with seeds fed to monkey.
		I	II	I	II		I	II	
Seeds sown	—	200	200	16	20	200	200	100	8
Days before germination	—	31	25	42	39	33	17	17	18
Days germinating	—	16	23	11	11	15	9	9	9
Seeds germinated	—	77	74	4	2	34	96	46	2
Per cent germination	—	38.5	37	25	10	27	48	46	25

[a] The seeds given to chickens were digested, so could not be planted

TABLE VII.—*Summary of results on the rate and percentage of germination of seeds of Libuton abaca as influenced by the time of planting.*

	Variety: Libuton.		
	Months.		
	June.	July.	August.
Date of sowing	June 6, 1922	July 6, 1922	Aug 8, 1922
Seeds sown	200	200	200
Days before germination	17	24	30
Days germinating	45	67	20
Seeds germinated	100	51	37
Per cent germination	50	25 5	18 5

NOTE:—200 seeds sown in each of the months from August, 1922, to February, 1923, inclusive, gave a germination percentage of nil.

ABSORPTION OF COMPLETE CULTURE SOLUTIONS BY ABACA ROOTS WITH REFERENCE TO GROWTH OF BRANCH ROOTS[1]

By R. B. ESPINO and S. M. CRUZ

WITH ONE PLATE

The rate of absorption of complete culture solutions by the roots of abaca has hitherto been practically neglected. Copeland (1) appears to have been the only investigator to make any report on the subject. He reports that the "general average of daily absorption by the roots, including some which took up but very little water, is not quite one third of a gram". On three roots only, selected as especially active, he reports that the average daily absorption was 0.5084 gram of water.

In this report, the only one available on the subject, water was used as a medium in the absorption experiments. Pure water is unsuitable as a culture medium for higher plants as it does not supply the essential mineral elements. Moreover, in order to become most beneficial or effective these elements should be not only in the right proportion or combination but should be supplied to the plant in the right concentration and amount. In view of these facts it was decided to make a study on the absorption of complete nutrient solutions by the roots of abaca plant. It was expected that from this study it might be possible to determine not only the amount of nutrient solutions an abaca plant absorbs in a given time but also the combination or proportion most readily absorbed.

The study here presented was conducted at the Abaca Nursery of the College of Agriculture, Los Baños, during the college year 1922 to 1923.

MATERIALS AND METHOD

CULTURE SOLUTIONS EMPLOYED

Eight different sets of molecular salt proportions, as shown in Table I, were used and each culture solution contained three salts. No two solutions had the same salt molecular proportions, but all of them had the same total concentration of 0.0245 gram-molecule (of all the salts taken together) per liter. This set is here designated as the 3-salt type.

In another set of cultures, which is here known as the 4-salt type, twelve culture solutions in different molecular salt proportions, but of the same concentration, were used (see Table II). Each culture solution had a total concentration of 0.0384 gram-molecule of all the salts per liter.

PREPARATION OF THE SINGLE-SALT STOCK AND CULTURE SOLUTIONS

In the preparation of the four single-salt stock solutions, distilled water and "Baker's analyzed" mono-potassium phosphate, calcium nitrate, magnesium sulphate, and ammonium sulphate, were used. Each of the four solutions was prepared in half-molar concentration. A few drops of a solution of ferric chloride were added to the stock culture solution.

[1] Thesis presented for graduation from the College of Agriculture, No 152; Experiment Station contribution No. 124.

About 30 cubic centimeters of each culture solution were poured into a test tube. The test tube with its contents was weighed. About five centimeters in length of the tip of a root of abaca was immersed in the solution. In the first part of the study, each culture solution supplied to the root was renewed at the end of every two days.

OTHER PREPARATIONS

The roots were dug out of the ground, care being taken not to injure them. They were then washed with water, placed in test tubes for about three days to allow them to recover from the shock before being immersed in the solutions. At the end of the period the roots were immersed in the solutions, one root to each solution. The mouths of the test tubes were plugged with paraffined corks with holes in the center through which the roots were inserted. Then the preparations were covered with banana leaves so as to protect the roots from the drying influence of air, from the rain, and to keep them in darkness. For further protection from any possible disturbing effects of rain and sun a shed thatched with cogon leaves was put over the experiments. Care was exercised to effect renewal of solutions within the shortest time possible. The amount of solution absorbed was determined by weighing.

FURTHER PLAN OF EXPERIMENTS AND RESULTS

Eight roots from one hill of the Maguindanao variety of abaca were supplied with the eight culture solutions of the 3-salt type (see Table I). Each culture solution was tried on every root but on different days. Each of these solutions had a concentration of 0.0245 gram-molecule (of all salts taken together) per liter and was renewed at the end of every two days. A mass of numerical data on this part of the experiment was collected.

Each of the 12 culture solutions of the 4-salt type was tried also on every root of another set of twelve roots from the same hill. The solutions had a concentration of 0.0384 gram-molecule of the salts taken together per liter. The amounts of the culture solutions that entered the roots at the end of each experimental period were determined by weighing.

GROWTH OF BRANCH ROOTS

About two or three weeks after the experiments were started branch roots began to grow quite rapidly from the main root. Not all the *initial* roots employed in the experiments, however, developed these structures. Representatives of those that did develop them were gathered at the end of the experiments and are reproduced in Plate I.

Because of the appearance of branch roots in some of the culture solutions tested, the amount absorbed in a two-day period was considerably increased. These branch roots therefore may be considered as a *modifying factor* in the experiment.

Inasmuch as not all the data on hand were obtained as absorbed by a single root in a given time, it was absolutely impossible to interpret some of the results. For this reason it was decided to pick out from this mass of data absorption readings made during the experiments when the modifying factor mentioned above was not present. However, for the sake of comparison some of the absorption readings taken near the end of the experiments and when the modifying

factor was at work were included. The data referred to for the 3-salt culture solutions are given in Table III, and for the 4-salt culture solutions in Table IV. The corresponding weather records are also given in Tables III and IV.

DISCUSSION OF RESULTS

GROWTH OF BRANCH ROOTS, A DISTURBING, OR MODIFYING FACTOR

As originally planned the absorption-tests with 3-salt and 4-salt types of culture solutions were made in a *rotation*, or *cycle* system. With this arrangement it would have been possible to compare the rate at which the culture solutions in a set were taken in by the roots of abaca. Unfortunately, about two or three weeks after the experiments were started, branch roots were produced on the portion of the *initial* roots immersed in the solution. The disturbance caused by the branch roots upon the rate of absorption was not realized until the experiments were ended. When the data were studied it was then noticed that the growth of branch roots was usually accompanied by a corresponding increase in absorption hence the figures representing absorption made by one root were not comparable with the absorption by several roots. The data in Table II show that the five highest records on absorption (5.59, 3.41, 4.80, 4.02 and 3.73 grams) made *per root* were far smaller than the five highest records (15.93, 16.84, 12.49, 19.63 and 11.56 grams)made *per several roots*. A similar case may also be seen in Table IV. An attempt is here made to explain the probable cause and significance of the growth of the branch roots referred to above.

The data were obtained from which it could be determined whether or not the branch roots were the result of an unsuitable concentration of the culture solutions. But casual observations with water culture experiments in general seem to show that a profuse production of roots in solution was usually caused by a rather strong concentration of the solution, as Haberlandt (3) reports, a medium (solid or liquid) which is not in the right condition for a plant generally causes a profuse production of roots thereby increasing the surface for absorp. tion. From this brief discussion it may be inferred that the production of growth of many branch roots in this study suggests that the concentration of culture solutions tested was rather strong for this plant. Further investigation in the same field should include tests of many different concentrations. The growth of branch roots opens a problem of physiologico-morphological nature, a study of which would have been attempted if time had permitted.

Another question may be raised as to whether or not the growth of the branch roots was due to a particular molecular proportion or combination of the salts employed. An examination of the data on hand, but not here published, and in Tables III and IV, may show that the different culture solutions tested were rotated among the different roots studied in such a way that it was impossible for a *particular* culture solution to have influenced the growth of branch roots from a *particular initial* root immersed in the solution. Moreover, our records show that not all the roots studied produced branch roots, though each of the *initial* roots was supplied with all the solutions in a set. It is, therefore, evident that the growth of the branches was not due to the molecular proportions or combinations of the salts nor to the presence of ammonium sulphate or of sodium nitrate in the media, as in both types of cultures some *initial* roots produced branches while others did not.

MAXIMUM ABSORPTION OF CULTURE SOLUTIONS

Although not exactly comparable, for the solutions were supplied to different sets of roots from the same clump of abaca, the data in Tables III and IV seem to show that the addition of ammonium sulphate in complete culture solutions made the intake of the latter by the roots relatively slower. On the assumption that the type solution most readily absorbed would give a maximum nutritive benefit to the plant the data given in the upper portion of Table III is of importance as the most rapid absorption of the culture solutions per root is recorded here.

It would not be safe to say that some of the culture solutions of the 3-salt type are most suitable for abaca. But the average daily records of absorption that can be derived from most of the results recorded in the upper portion of Table III were higher than the 0.5084 gram reported by Copeland as the daily average absorption of *water* by the roots which were selected as especially active. The average absorption of 3-salt culture solutions (in italics in the upper part of Table III) would be 2.155 grams a root a day, or about 300 per cent greater than the result reported by Copeland.

In the absence of any possibility of actually determining the amount of solution that the roots of an abaca plant, or a clump of the variety Maguindanao when grown in Los Baños absorbed in a given period of time, it becomes advisable to make the necessary computations. Granting that 2.155 grams was correct, the roots on the clump of abaca[2] studied would absorb 2353.26 grams, or about 2.4 kilograms of the culture solution in a day. A full grown plant[2] would absorb 230.585 grams or about 0.23 kilogram per day.

As regards the characteristics of G_3, a culture solution relatively the most readily absorbed of the 3-salt type, it appears that the solution referred to was composed of 0.0105 gram-molecule of mono-potassium phosphate; 0.0105 gram-molecule of calcium nitrate and 0.0035 gram-molecule of magnesium sulphate. It must be understood that this conclusion is only tentative. Further investigations should be conducted to fully establish its validity. Assuming that this conclusion is correct, it appears that the coconut (variety Laguna) and abaca of the variety studied differ from each other in salt requirement in that the coconut required ammonium sulphate in a completely balanced solution, while the abaca did not need it. These two plants seem to differ further from each other in that for a rapid absorption the coconut (4) required a culture solution, which contained an extremely low content of ammonium sulphate, mono-potassium phosphate or calcium nitrate and an extremely high amount of magnesium sulphate.

SUMMARY OF CONCLUSIONS

The limited amount of data on hand and the conditions under which this study was made warrant only the following tentative generalizations:

(1) That a profuse growth of branch roots were produced when roots of abaca were supplied with 3-salt or 4-salt types of culture solutions tested.

(2) That the ultimate cause of the growth of the branch roots was not determined, but that it appears entirely probable that a *particular* molecular proportion of the salts in the cultures was not responsible for their development.

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[2] The clump of abaca studied had 9 large and 3 medium sized plants; 107 roots were found on a large plant and 41 roots on a medium sized plant.

(3) That two or more problems of a physiologico-morphological nature were brought out in this study.

(4) That the complete culture solutions with ammonium sulphate were in most cases less readily absorbed than the complete culture solutions without it—indicating that the salt was not needed by the plant.

(5) That the average daily absorption of the five highest readings obtained was 2.155 grams per root per day, or about 300 per cent more readily absorbed than water as reported by Copeland.

(6) That by computation, an abaca plant of the variety studied would absorb about 0.23 kilogram of the culture solution (found most readily absorbed) a day. On a similar basis the roots of the clump of the plant would take in about 2.4 kilograms of the solution in a day.

(7) That the culture solution most readily absorbed was characterized by having relatively medium amounts of either mono-potassium phosphate or calcium nitrate and a relatively high content of magnesium sulphate.

ACKNOWLEDGMENT

Thanks are due to Mr. Teofilo Novero, of the Department of Agronomy, for his help in checking the computations and to Mr. Moises Villaluz for making the drawings in Plate I.

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ILLUSTRATIONS

PLATE I

Roots of abaca that were immersed in culture solutions

Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7: Branch roots comparatively few and some just beginning to appear.

Figure 8, Figure 9, Figure 10: Profusely branched.

TABLE I.—*Molecular proportions* [a] *of three salts in each culture solution of the 3-salt type.*

(Each solution had a total concentration, 0 0245 gram-molecule of all the salts taken together per liter)

Culture solution.	Gram molecules of each salt in culture solutions.		
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
A_3	0.0035	0.0035	0.0175
B_3	0.0035	0.0105	0.0105
C_3	0.0035	0.0175	0.0035
D_3	0.0070	0.0070	0.0105
E_3	0.0070	0.0105	0.0070
F_3	0.0105	0.0035	0.0105
G_3	0.0105	0.0105	0.0035
H_3	0.0175	0.0035	0.0035

a Some of the culture solutions employed by Espino (2)

TABLE II.—*Molecular proportions* [a] *of the salts in each culture solution in the 4-salt type.*

(Each solution had a total concentration, 0 0384 gram-molecule, of all salts taken together, per liter)

Culture solution.	Gram-molecule of each salt in culture solutions.			
	$(NH_4)_2SO_4$	NH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
A_4	0.0048	0.0048	0.0048	0.0240
B_4	0.0048	0.0048	0.0144	0.0144
C_4	0.0048	0.0048	0.0240	0.0048
D_4	0.0048	0.0096	0.0096	0.0144
E_4	0.0048	0.0096	0.0144	0.0096
F_4	0.0048	0.0144	0.0048	0.0144
G_4	0.0048	0.0144	0 0144	0.0048
H_4	0.0048	0.0240	0.0048	0.0048
I_4	0.0144	0.0048	0.0048	0.0144
J_4	0.0144	0.0048	0.0144	0.0048
K_4	0.0144	0.0144	0.0048	0.0048
L_4	0.0240	0.0048	0.0048	0.0048

a Some of the culture solutions employed by Espino (2).

TABLE III.—*Rate of absorption of complete 3-salt culture solutions by roots of abaca, variety Maguindanao.* [a]

(All readings in grams)

Condition of roots.	Culture solutions.	Root 1	Root 2	Root 3	Root 4	Root 5	Root 6	Root 7	Root 8	No. of day intervals.
		A3	B3	C3	D3	E3	F3	G3	H3	
Single roots without large branches	*Date* Oct. 2-4	2.04	1.25	1 98	3.12	1.63	1.01	1.29	1.82	2
	Oct. 4-6	2.73	1.22	1.71	2.76	1.16	1.57	1.61	1.58	2
	Oct. 6-8	1.22	0.79	1.33	1 49	0.80	1 36	1.43	3.00	2
	Culture solutions.	H3	A3	B3	C3	D3	E3	F3	G3	
	Date Oct. 8-10	2.36	1.85	0 62	2.06	*5.59*	0.30	0.35	*4.80*	2
	Oct. 10-12	0.57	2.55	1.47	2.34	2.70	0 02	0.44	*4.02*	2
	Oct. 12-14	0.74	2.79	2.68	2.42	3 41	0.02	1 22	*3.73*	2
With fully developed branch roots	Culture solutions.	G3	H3	A3	B3	C3	D3	E3	F3	
	Date Dec. 1-3	1.32	3.64	2.85	6 43	1.25	2.85	1.05	1.23	2
	Dec. 3-5	2.25	5.78	7.12	6 34	11 56	3.54	4 25	1.88	2
	Dec. 5-7	1.61	5.82	5 72	9 58	8.01	6.09	4.22	5.40	2
	Culture solutions.	F3	G3	H3	A3	B3	C3	D3	E3	
	Date Dec. 7-9	4.02	0.22	7.39	8 79	16.04	12.49	7.97	4 27	2
	Dec. 9-11	6.08	0 73	1 66	15.93	8.80	19 63	7 86	4.41	2
	Dec. 11-13	5.30	1.51	5 21	5.68	9 45	8.01	6 01	4 11	2

[a] For climatic conditions see Table V.

TABLE IV.—*Rate of absorption of complete 4-salt culture solutions by roots of abaca, variety Maguindanao.*[a]

(Al readings in grams.)

Condition of roots.	Date	Root 1.	Root 2.	Root 3.	Root 4.	Root 5.	Root 6.	Root 7.	Root 8.	Root 9.	Root 10.	Root 11.	Root 12.	No. of days interval.
Single roots without large branches	Culture solutions.	A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	K4	L4	
	Date													
	Oct 2-4	1.04	1.08	*4.60*	1.20	4.45	0.98	1.21	1.23	1.01	0.65	0.65	1.57	2
	Oct. 4-6	1.34	0.93	*3.39*	1.30	3.00	0.67	0.72	1.45	0.60	1.15	0.93	0.64	2
	Oct 6-8	0.77	1.43	1.54	1.32	1.07	0.64	0.41	1.54	1.49	0.68	2.40	0.66	2
	Culture solutions.	L4	A4	B4	C4	D4	E4	F4	[G4	H4	I4	J4	K4	
	Date													
	Oct. 8-10	0.19	2.19	1.11	0.14	*3.42*	0.67	0.69	1.36	0.76	1.05	0.67	0.72	2
	Oct. 10-12	1.50	1.81	0.79	0.10	0.01	0.55	0.68	7.15	0.12	1.66	0.02	3.52	2
	Oct. 12-14	0.80	3.15	1.07	0.07	2.22	1.32	1.00	1.89	1.23	1.09	1.55	2.06	2
With fully developed branch roots	Culture solutions.	C4	D4	E4	F4	S4	H4	I4	J4	K4	L4	A4	B4	
	Date													
	Dec 1-3	2.45	1.25	0.64	2.95	1.01	0.84	1.01	0.84	0.11	0.11	0.16	2.86	2
	Dec. 3-5	0.44	4.44	6.17	1.09	0.85	3.37	1.31	1.67	0.93	0.06	0.70	0.13	2
	Dec. 5-7	0.06	*7.81*	3.49	7.56	2.60	1.15	3.41	2.51	0.50	0.08	0.31	0.53	2
	Culture solutions.	B4	C4	D4	E4	F4	G4	H4	I4	J4	K4	L4	A4	
	Date													
	Dec. 7-9	0.21	0.63	*2.63*	4.74	7.10	2.17	0.80	5.46	6.48	1.83	0.23	0.10	2
	Dec. 9-11	0.89	0.33	1.69	3.90	6.30	2.83	1.26	9.87	3.07	0.89	0.31	1.09	2
	Dec. 11-11	0 52	0.05	7.75	3.34	7.46	2.52	1.05	3.36	2.48	0.49	0.08	0.31	2

[a] For climatic conditions see Table V

TABLE V.—*Climatic conditions during experiments recorded in Tables III and IV.*

Temperature.				Date.
Maximum.	Optimum.	Minimum.		
30	28	26	Sunny	Oct. 2
30.1	28.1	26	Cloudy	3
30.1	28.1	26	Cloudy	4
30.1	27.5	25	Cloudy	5
30.1	27.5	25	Cloudy	6
30.1	27.5	25	Cloudy (slightly)	7
30	27.5	25	Very cloudy, some rain	8
30	27.5	25	½ Cloudy	9
30	27.5	25	¼ Cloudy	10
29	27	25	Cloudy nearly all day	11
29	27	25	Cloudy nearly all day	12
30	28	26	½ Cloudy	13
30	26	26	¼ Cloudy	14
27	26	25	Cloudy all day	Dec. 1
28	26.5	25	Cloudy	2
27	25.5	24	Cloudy	3
27	25.5	24	Cloudy	4
27	25.5	24	Cloudy	5
28	26.5	25	¾ Cloudy	6
29	26.5	24	¾ Cloudy	7
28	25.5	23	¾ Cloudy, no rain	8
27	25 5	24	Cloudy, occasional rain	9
29.5	27.3	25	1/5 Cloudy, no rain	10
29	26	23	1/5 Cloudy, no rain	11
27 5	26.3	25	Cloudy all day, light rain	12
28	25 5	23	Cloudy all day, no rain	13

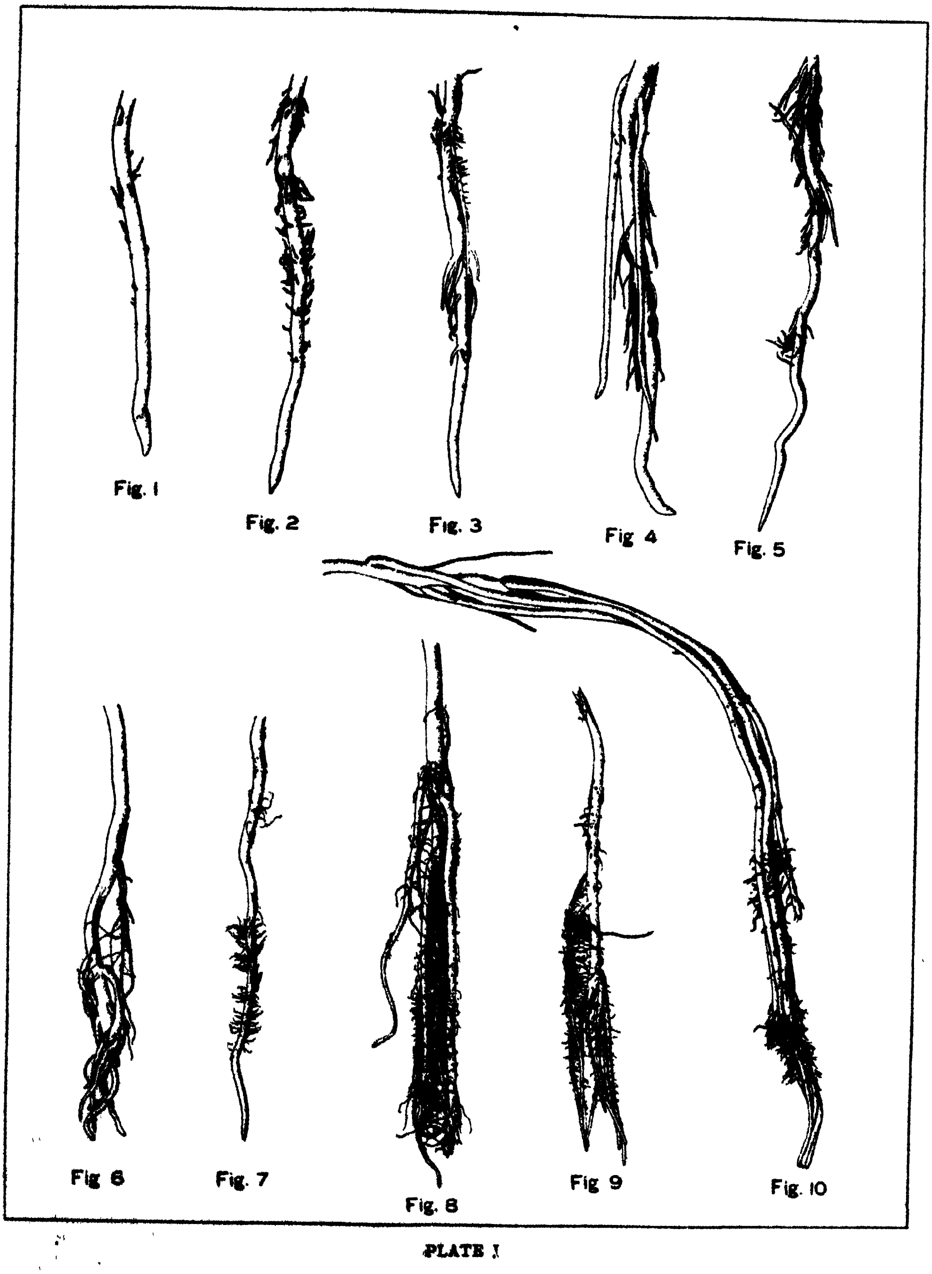

PLATE I

SOIL MOISTURE REQUIREMENTS OF YOUNG ABACA PLANTS[1]

By P. Hernais and R. B. Espino

Although abaca fiber is strictly a Philippine product and one of our most important exports, very little is known about the water requirements of the plant that produces it. The distribution of abaca in the Islands is limited by climate; it grows well in only a few provinces. Experience shows that the principal factor of climate that limits the distribution of this crop in this country is drought. Experience further shows that in many cases irrigation water has saved valuable abaca plantations during the dry season. But irrigation in many localities is either wanting or is very deficient. Moreover, the results obtained in the study here reported seem to show that this plant has an optimum requirement for soil moisture. It can stand neither too wet nor too dry a soil. For this reason to be able to use irrigation water economically and judiciously and to pick out suitable planting places a knowledge of the right amount of water needed by the plant is essential.

This study was undertaken with the aim of determining the soil moisture requirements of young abaca plants. The work was carried out only up to the seedling stage of the plant, hence, the results here presented are to be considered as preliminary only. They should be considered, also, as holding good only under the conditions of this experiment.

This study was conducted at the College of Agriculture, Los Baños, and covered a period of two years, from September, 1919, to September, 1921.

MATERIALS AND METHOD

THE SOIL

Kind and source.—The soil used was of the mellow loam type. It was taken from an alluvial deposit along the bank of Molawin Creek which runs through the College Farm and was fertile and fairly suitable for the normal growth of the abaca plant.

Amount and degree of saturation.—There were six sets of cultures in Trial I and six sets in Trial II. Each set had soil with a certain degree of water saturation. Each culture was run in quintuplicate and had fifteen kilograms of dry soil. The cultures that had soil saturated with water were considered 100 per cent saturation. The other degrees of saturation, 70, 50, 30, 20, and 10 per cent, were computed on this basis. Each degree of saturation was maintained by weighing each pot at intervals of forty-eight hours. The loss in weight was considered, although it is not accurate, as the amount of water absorbed or transpired by the plant for the period of time since previous weighing. The loss in weight of each culture was replaced with an equal amount of water. Thus the initial degree of saturation of each culture was maintained as closely as possible. There was a certain amount of error believed to be unavoidable due to the weight

[1] Thesis presented for graduation from the College of Agriculture, No. 153; Experiment Station contribution, No. 125.

of the plant in each culture. The results obtained in this study are of value as a preliminary study on the subject.

SEEDS AND SEEDLINGS

A sufficient quantity of seeds were collected from a bunch of ripe abaca fruit of an unknown variety in Indang, Cavite Province. These seeds were dried for a short time and sown in a germinating box containing alluvial soil. After about a month most of the seeds germinated. When the seedlings were about five centimeters in height, vigorous and uniformly developed ones were first grown in porcelain vessels containing two liters of soil each. These vessels had no drainage hole in the bottom. Each vessel of soil contained a certain degree of saturation. To reduce the rapid evaporation of water from the soil and to prevent rain water from getting into it the upper end of the container was sealed with paraffined paper. A short piece of glass tubing for the passage of air and of water whenever the latter was added was inserted through paper cover into the soil in the pot. The seedlings were allowed to grow in these containers until they were large enough to be transplanted into larger receptacles, in this case five-gallon kerosene cans. No further treatment was given to the plants, except to keep them under the shade and free from rain. The insect enemies of the plants were killed as soon as discovered on or about the plants.

EXPERIMENTS AND RESULTS

EXTERNAL APPEARANCE OF THE PLANT

The external appearance of the plants was observed at the time of harvest. The data for both Trials I and II are given in Table I.

OTHER INDICATIONS OF RESULTS

Other indications of results were employed. These were (a) total growth, (b) height of plants, (c) number of leaves, (d) approximate area of leaves, (e) green weight of lamina and petiole, (f) diameter of stalk at base, (g) green weight of false stalk, and (h) green weight of whole top. The data under each of these criteria were gathered at the time of harvest.

Total growth.—Weekly measurements of the plant in each culture were made. The growth of each leaf was recorded. The sum of the growth of all the leaves in a week constitutes the total growth of the plant during the week. The sum of all weekly growths of each plant from the beginning until the end of the study forms the total growth of the plant.

Height of plants.—The total height of the plants from each culture was measured from the base of the stem to the top of the tallest leaf.

Number of leaves.—The leaves produced by each culture from the beginning to the end of the experiment were counted.

Approximate area of leaves.—The length and width of each leaf were measured and the product found of the dimensions. This product was considered the approximate area of the leaf. The sum of the approximate areas of all the leaves from each culture constitutes a result under this criterion.

Diameter of stalk at the base.—At about two centimeters above the surface of the soil in each pot, the diameter of the stalk of each culture was measured with calipers.

Green weight of lamina and petiole.—All the blades and petioles of the leaves from each culture were weighed soon after harvest.

Green weight of false stalk.—After cutting off the blades and the petioles of the leaves and removing them from the plant in each culture, the remaining portion of the stalk was weighed.

Green weight of whole top.—The numerical data in *e* were added to the corresponding data in *g*. This sum gives the weight of the whole top.

The data under these criteria are given in Tables II and III.

DISCUSSION OF RESULTS

EXTERNAL APPEARANCE OF PLANTS

As shown in Table II the results obtained from the cultures in Trial I were better than those from the corresponding cultures in Trial II. This difference was caused by the time of planting of the two trials. Trial I was started in the month of September when rain fell frequently, consequently the drying influence of the air was not great. The cultures in Trial II, however, were started during the summer when the temperature was fairly high. As a consequence, two out of five of the cultures provided with 50 per cent saturation in Trial II died, while none died in the similar cultures in Trial I. Moreover, the plants in Trial I were about sixteen months old at the time of harvest; while those in Trial II were harvested at the age of about nine months.

Two of the five cultures in saturated soil in Trial II died; none died from similar cultures in Trial I. However, the death of some of the cultures and the apparent stunted and yellowish condition of the others in Trial II, was only in very small part due to the drying influence of the air over the cultures. It was largely due to the presence of too much water in the soil which interfered with certain biological processes taking place in it. Because of lack in supply of oxygen in the saturated soil the respiration of the roots was probably interfered with. This lack in oxygen supply was the cause, also, of the stunted and yellowish condition of plants in Trial I.

Of all the cultures tested, those with 70 per cent saturation produced the most vigorous plants. The plants in these cultures had long, broad, and green leaves. They, also, had relatively large stalks. Four out of five cultures with 70 per cent saturation in Trial I produced suckers. No other cultures in either trial produced suckers.

These results confirm the experience of some abaca growers that this plant can not successfully be grown in regions where drought occurs at least once a year, or in soil saturated with water. Moreover, these results quantitatively establish the water need for the maximum development of the young plants when grown in pots containing alluvial soil and under the climatic conditions observed during the study.

OTHER INDICATIONS OF RESULTS

The cultures with 70 per cent saturation gave the highest results under all the criteria indicated in Table II. This was true both for Trials I and II as shown in Table III. The data in Table III show that under Trial I the *70 per cent saturation* was 31 per cent superior to the *100 per cent saturation* and 24 per cent better than the *50 per cent saturation*. In Trial II the results obtained from the cultures with *70 per cent saturation* were 59 per cent superior to those from

the *saturated soil* and 57 per cent over those obtained from the cultures that had *50 per cent saturation*.

The results in terms of the criteria, indicated in Tables II and III, fully confirm those in terms of the external appearance of the plant. These results further emphasize the superiority of the cultures with 70 per cent saturation over the other cultures supplied with more or less amount of water.

SUMMARY OF CONCLUSIONS

From the results of this study the following conclusions (under the conditions of the experiments) are fairly accurately established:

1. That of all the degrees of saturation of the soil in pots, 70 per cent promoted the best vegetative development of the young abaca plant. This was true with Trial I started during the rainy season as well as with Trial II started during the dry season.

2. That seedlings of abaca could not be grown even in a fertile soil when it had less than about 50 per cent saturation.

3. That the young abaca plant could not thrive well in alluvial soil saturated with water. This confirms the common observation or experience of abaca growers.

4. That the optimum moisture requirements of the young plant probably lies somewhere between 60 and 80 per cent saturation.

TABLE I.—*External appearance of the plants at the time of harvest.*

Saturation.	Culture No.	Trial I.	Trial II.
per cent			
100	A_1	Yellowish narrow leaves	Yellow leaves; stunted in growth
	A_2	Yellow leaves short and narrow; stalk short	Yellow leaves, narrow and short
	A_3	Yellow leaves; stalk small and short	Dead
	A_4	Yellow leaves; stalk small and short	Yellow leaves; small stalk
	A_5	Yellow leaves long but narrow; stalk small and short	Dead
70	B_1	Green leaves; vigorous and big stalk. Produced suckers	Green broad leaves; vigorous in growth
	B_2	Green leaves broad and long; big stalk. Suckers are produced	Green and broad leaves; big stalk
	B_3	Green leaves, broad and long; big stalk. Suckers are produced	Green leaves; big stalk
	B_4	Green leaves, broad and long; stalk big	Green narrow leaves; big stalk
	B_5	Green leaves, broad and long; suckers produced	Green leaves; stalk long
50	C_1	Green leaves, wider than those from saturated	Dead
	C_2	Green leaves, long but narrow	Greener leaves than those from saturated
	C_3	Green leaves, long but narrow	Green leaves, long but narrow
	C_4	Green leaves, narrower than those from 70 per cent saturation	Green leaves; bigger stalk than any in saturated
a	C_5	Dead	Dead

a All cultures with 30, 20, and 10 per cent saturation, died

TABLE III.—*Relative value*[a] *of average results from cultures with 100, 70 and 50 per cent saturation in both trials.*

	Trial I.			Trial II.		
Per cent saturation	100	70	50	100	70	50
Indications of results.						
1. Total growth, *cm.*	68	100	70	58	100	56
2. Height of plants, *cm.*	79	100	92	48	100	52
3. Number of leaves	87	100	100	92	100	70
4. Approximate area of leaves, *sq. cm.*	67	100	78	31	100	27
5. Green weight of lamina and petiole, *gm.*	64	100	72	24	100	35
6. Diameter of stalk, *cm.*	76	100	79	34	100	44
7. Green weight of stalk, *gm.*	59	100	59	19	100	28
8. Green weight of top, *gm.*	53	100	62	19	100	29
Average of relative values	69	100	76	41	100	43

[a] The highest value under each criterion in either trial was considered 100 and the other values under the same indication of result were computed accordingly.

TABLE II.—*Results obtained under different criteria at the time of harvest.*

Trial I.

Degree of saturation.	Culture number.	Total growth.	Height of plants.	Number of leaves.	Area of leaves (approximate).	Green weight of lamina and petiole.	Diameter of stalk.	Green weight of false stalk.	Green weight of whole top.
per cent		*cm.*	*cm.*		*sq. cm.*	*gm.*	*cm.*	*gm.*	*gm.*
100	A*1*	341.7	78.5	20	2,169.75	36.2	3.10	127.4	163.6
	A*2*	242.9	63.3	22	1,455.6	28.5	2.80	90.8	119.3
	A*3*	292.8	72.4	22	1,463.1	49.5	3.10	115.3	164.8
	A*4*	248.1	59.7	26	1,075.55	34.4	2.40	53.0	87.4
	A*5*	243.1	68.5	16	1,630.05	77.4	2.65	222.5	200.0
70	B*1*	412.5	84.4	28	2,319.29	83.5	3.50	174 8	258.3
	B*2*	384.5	82 7	21	1,915.10	63.5	3.50	196.0	259.5
	B*3*	407.9	87.0	23	2,414.75	65.2	3.40	202.5	267.5
	B*4*	354.3	88 5	23	2,415.95	63.7	3.90	223.5	282.7
	B*5*	480.2	92.6	23	2,586.2	74.7	4.00	239.0	313.4
50	C*1*	327.4	78.5	23	1,963.55	50.3	3.05	130.6	180.9
	C*2*	130.2	74.0	26	824.10	50.6	2.15	59.4	110.0
	C*3*	333.5	80.3	25	2,197.92	56.2	3.40	133.8	190.0
	C*4*	347.1	86.1	24	2,344.97	43.2	3 30	162 1	205.0
	C*5*	dead	dead	—	—	—	—	—	—

Trial II.

Degree of saturation.	Culture number.	Total growth.	Height of plants.	Number of leaves.	Area of leaves (approximate).	Green weight of lamina and petiole.	Diameter of stalk.	Green weight of false stalk.	Green weight of whole top.
100	A*1*	35.5	11.3	6	154.00	2.4	0.2	4 2	6.6
	A*2*	35.5	21.6	5	137.00	4 4	0.8	5.2	9.6
	A*3*	dead	—	—	—	—	—	—	—
	A*4*	43.7	19.3	6	168.85	2.2	0.5	3 6	5 8
	A*5*	dead	dead	—	—	—	—	—	—
70	B*1*	dead	dead	—	—	—	—	—	—
	B*2*	72.6	29.4	7	430.85	9.0	1.5	12.2	21.2
	B*3*	85.7	46.2	6	694.85	18.0	2.1	33.2	51.5
	B*4*	81.2	37.5	7	396.10	12.2	1.9	28.3	40.5
	B*5*	72.5	32.2	5	461.95	11.0	1.3	17.5	38.5
50	C*1*	dead	dead	—	dead	dead	—	—	—
	C*2*	30.6	13.7	5	124.2	1.9	0.6	3.3	5.2
	C*3*	40.8	14.0	3	132.75	4.2	0.6	5.3	9 5
	C*4*	60.5	29.3	5	142.32	7.1	1.05	10 4	17.5
[a]	C*5*	dead	dead	—	—	—	—	—	—

[a] All cultures with 30, 20, and 10 per cent saturation, and in Trial II 40 per cent also, died.

A PRELIMINARY STUDY OF THE SALT AND FERTILIZER NEEDS OF THE YOUNG ABACA PLANT[1]

By R. B. ESPINO and B. O. VIADO

WITH ONE TEXT FIGURE

Although the abaca plant is generally grown in virgin soil, results from studies of its fertilizer requirements should be of some value. In tests of this kind with cultivated crops it has been shown that a judicious application of fertilizer was generally followed by a more productive yield, indicating that, though the quality and the quantity of the good ingredients might not be lacking, the proportion of the principal constituents might require adjustment. Also, if the same crop is harvested year after year from the same land as in the case of abaca, the steady though moderate reduction of the fertility of the field, will ultimately make the soil poor in mineral nutrients. Moreover, results of experiments on the salt and fertilizer needs of crops seem to show that they have individual requirements, not only in the kind of fertilizer material but also in the proportion and amount.

Evidence is not wanting which tends to show the influence of certain kinds and amounts of fertilizers on the production or development of certain structures in the plant body. No study of the abaca plant with the object of observing this influence has been made. Other plants, however, have been observed to respond favorably, and in some cases, extraordinarily, to the action of certain fertilizers. For instance, it has been found in this College that an increased production of oil could be obtained as a result of the application of fertilizers to the soil where the peanut is grown. Sugar cane has been found to produce more sucrose when supplied with certain kind and proportion of fertilizers.

One of the objects of the present study was to find whether or not application of a certain fertilizer to the young abaca plant would be accompanied by an increased yield of fiber or by the production of fiber of certain special quality. Another object was to find fertilizer combinations that would promote the most vigorous vegetative growth of the crop.

The present study was conducted at the College of Agriculture for the period from June, 1920, to September, 1921. The study was made on two series of cultures. The first series was supplied with certain chemicals with the intention of obtaining quick results. The second series was supplied with ordinary commercial fertilizers.

MATERIALS AND METHODS

THE SOLID MEDIUM

In both series of cultures the soil used was clay loam and was taken from a field east of the Seed Laboratory which had been previously planted to cassava and had never received any application of fertilizer. The amount of soil required for each of the series of cultures was collected, thoroughly pulverized and mixed, before putting it in the pots[2] and pilones[3]. Each pot was filled to about two centimeters from the brim.

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[1] Thesis presented for graduation from the College of Agriculture, No 154; Experiment Station contribution, No. 126.

[2] Earthen flower pot No. 6, capacity 2 liters, used for Series I.

[3] Ordinary earthen receptacle for sugar in the Philippines; conical shape, broad end at top, narrow end at the bottom with drainage hole; capacity 45 liters, used for cultures in Series II.

THE SEEDS AND SEEDLINGS

On July 4, 1920, and again on January 6, 1921, ripe fruit of abaca of an unknown variety were secured from Indang, Cavite. The seeds were separated from the fruit and washed with water to remove the pulp.

They were then germinated in seed plots which were kept moist by watering them every other day. After about a month the seeds germinated and when the seedlings had attained a height of about five centimeters, or possessed four visible leaves, uniformly developed seedlings were transplanted to the pots, one seedling to each pot.

THE NUTRIENT MEDIA

In both series of cultures the triangular method of apportioning the nutritive constituents proposed by Schreiner and Skinner[4] was followed. In Series I, 19 cultures out of 153 in a triangular set were used and each culture was run in triplicate. The triplicate cultures are designated by *a*, *b*, *c*. Three control cultures were employed. Table I shows the proportions and actual amounts of the chemicals, potassium acid phosphate, calcium nitrate, magnesium sulphate, used. The amounts shown in the table were supplied to the plant in four different applications at bi-weekly intervals.

In Series II, nine cultures were used; four cultures without fertilizers, for the control. The cultures were run in quadruplicate as designated by *a*, *b*, *c*, *d*, and were supplied with two sets of fertilizer combinations: one is here designated as the *ammonium set* and the other as the *nitrate set*. The ammonium set was supplied with potassium sulphate, double superphosphate, and ammonium sulphate. The nitrate set had the same commercial fertilizers except that sodium nitrate was substituted for the ammonium sulphate. Table II shows the proportions and actual amounts of the fertilizers employed. The fertilizers were applied only once to the pilones and the application was made soon after the seedlings were properly set in the pilones.

CARE OF CULTURE

While the cultures in Series I were in progress, oiled paper was placed on the surface of the soil in each pot to prevent it from becoming too dry and to suppress the growth of weeds. To further check the rapid evaporation of water from the pot and from the plant and to protect the seedlings from the destructive violence of strong winds, a frame over which cheese cloth was stretched, was placed about a meter above the plants.

For the cultures in Series II, where the commercial fertilizers were used banana leaf sheaths cut in suitable sizes were employed to protect the seedlings from the intensity of the sunlight and the hard wind. The cultures were watered and cultivated when necessary.

EXPERIMENTS AND RESULTS

SERIES I., SALT SOLUTION SERIES

For the cultures in Series I, where the salt solutions were employed as the nutritive media, the following criteria of results are employed; namely, (1) growth in height, (2) weight of green top, (3) approximate area of leaves, and (4) number of roots.

[4] Schreiner O., and Skinner, J. J. Ratio of phosphate and potassium on absorption and growth. *Botanical Gazette 50*: 1-30. 1910.

Growth in height.—The weekly growth increment was measured once a week from a base mark on the surface of the ground to the tip of the youngest leaf in each culture. The numerical data for this are given in Table III.

Weight of green top.—The weight of green top was determined in each culture. The top from each culture was severed from the roots and weighed. Table III shows the weights of green tops.

Approximate area of leaves.—The approximate area of all leaves on each plant was determined. The length from the upper end of the petiole up to the tip of the leaf was multiplied by the width of the widest part of the leaf; the product represents the approximate area of each leaf.

The sum total of the areas of all the leaves from each culture is the approximate area indicated in Table III.

Number of roots.—The roots from each plant were counted. Only those which originated from the rhizome were included. The data are shown in Table III.

SERIES II. THE COMMERCIAL FERTILIZERS SERIES

Four indications of results are employed for the cultures where the commercial fertilizers were used. They are (1) length of tallest leaf, (2) diameter of stalk, (3) length of all leaves combined, and (4) the approximate area of all leaves combined.

Length of all leaves combined.—The length of all the leaves was also determined. From the base mark made, each leaf was measured separately. The length from the base mark up to the tip of every leaf was taken and the lengths of all the leaves were combined.

DISCUSSION OF RESULTS

THE SALT SOLUTION SERIES

From unpublished data the writers gathered that young abaca plants started from seeds are quite variable in size and behavior, although grown under similar environmental conditions. In spite of the influence of the fertilizers added to the cultures in the present study these natural individual variations in development were observed. Effort was made to correct this as much as possible by running each culture in triplicate. Since the data shown in Table III seem to show some discrepancy, a brief discussion is here given on the column, "corrected". This column shows the sum total of all separate data under the four criteria employed in this series of cultures.

The corrected data in both series of cultures as shown in Table III and Table IV were obtained in the same manner. The sum of the numerical data of the criteria employed in either series was divided by the number of living plants in each culture. The quotient obtained was then multiplied by the number of dead plants and the product was added to the original data.

Examining the figures for the sum total it will be seen that Cultures 7, 8, 10, and 11, especially the 7 and the 11 cultures gave good yield under the criteria of results here employed. To these four cultures may be added Culture 18, which, though affected by certain unknown disturbing factors not within control, gave a good yield. As it is not expected that many good cultures will be discovered in a limited set of cultures, such as here tested, two exceptionally good ones were

selected and their characteristics as regards the fertilizer materials studied. These cultures are characterized by having the following salt proportions:

	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
Culture 7	2	8	2
Culture 11	4	7	1

From the data, it is evident that for the best growth and development of the young abaca plant when grown in clay loam soil and under climatic conditions observed, a rather heavy application of calcium nitrate was needed. As for the other salts, potassium acid phosphate and magnesium sulphate, only a very moderate application of each was needed in order to obtain a good vegetative development of the plant. Culture 7 was 264 per cent better than the control.

THE COMMERCIAL FERTILIZER SERIES

In common with many other agricultural crops, abaca plants are materially influenced by the application of ammonium sulphate. Sodium nitrate was not so beneficial as ammonium sulphate. The plants in the ammonium sulphate set were much more vigorous and had greener leaves than those grown in cultures supplied with sodium nitrate. About 50 per cent of the seedlings supplied with sodium nitrate died, while of those which were supplied with the ammoniacal form of nitrogen, only two died. These facts tend to show the possibility of improving the vegetative growth of the plant by proper application of fertilizer.

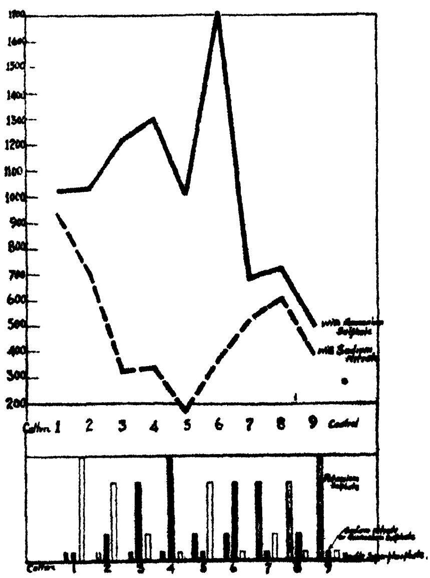

Figure 1. Graphs showing the comparative results from the different fertilized cultures; the ammonium set compared with the nitrate set.

It may even improve the quality and increase the quantity of the fiber produced. This supposition will require much experimentation before a reliable conclusion can be arrived at. The data under four different criteria of results are summarized in Table IV. The data in this table are graphed in Figure 1. This graph shows clearly and conclusively the superiority of the ammonium set of cultures over the nitrate set. Further examination of this graph shows that in the ammonium set the good results were obtained from Cultures 3, 4, and 6. These cultures are characterized by having relatively high amount of ammonium sulphate and moderate amount of either potassium sulphate and double superphosphate.

It appears from the curve representing the results obtained from the cultures supplied with sodium nitrate, that this form of nitrogen is unsuitable for this plant under the conditions of the present experiment.

Culture 10 (the control) as shown in Table IV and in Figure 1 gave much lower yield than any fertilized culture in the ammonium set. There were, however, four cultures in the nitrate set that gave a lower yield than the control. The best fertilized culture in the ammonium set was 383 per cent better than the control.

SUMMARY OF CONCLUSIONS

From the results obtained in this study it appears that the following generalizations may be drawn:

1. That the results from the present study are only preliminary in nature and hold good only under the soil and climatic conditions to which the young abaca plant used were subjected.
2. That the young abaca plant was benefited with a certain application of either calcium nitrate or ammonium sulphate.
3. That the ammonium sulphate was a far better source of nitrogen for this plant than sodium nitrate. For this reason, this plant belongs in the same category as the rice plant, tobacco plant, and several other agricultural crops as regards the source of nitrogen requirement.
4. That about 50 per cent of the seedlings out of the 36 cultures supplied with the sodium nitrate died during the very early stage of growth.
5. That in order to improve the nutritive condition of the loam soil generally used for abaca plantations and to promote a vigorous vegetative development of the young abaca plant a moderate application of either potassium sulphate and double superphosphate should be accompanied with a relatively heavy application of ammonium sulphate. The amount of ammonium sulphate should be from two to three times as much as either the potassium sulphate or double superphosphate.

TABLE I.—*Proportions and amounts of the three salts employed. 1333.3 cc. of solution to each culture with the molar concentration indicated below.*

Culture No.	Proportions of salts.			Volume of molar stock salt solutions.		
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
1	1	1	10	0.0041	0.0041	0.0410
2	1	4	7	0.0041	0.0164	0.0287
3	1	7	4	0.0041	0.0287	0.0164
4	1	10	1	0.0041	0.0410	0.0041
5	2	2	8	0.0082	0.0082	0.0388
6	2	5	6	0.0082	0.0205	0.0246
7	2	8	2	0.0082	0.0328	0.0082
8	3	3	6	0.0123	0.0123	0.0246
9	4	1	7	0.0164	0.0041	0.0287
10	4	4	4	0.0164	0.0164	0.0164
11	4	7	1	0.0164	0.0287	0.0041
12	5	2	5	0.0205	0.0082	0.0205
13	5	5	2	0.0205	0.0205	0.0082
14	6	3	3	0.0246	0.0123	0.0123
15	7	1	4	0.0287	0.0041	0.0164
16	7	4	1	0.0287	0.0164	0.0041
17	8	2	2	0.0328	0.0082	0.0082
18	10	1	1	0.0410	0.0041	0.0041
19	Control					

TABLE II.—*Proportions and actual amounts of the three commercial fertilizers added to the cultures in the ammonium set and nitrate set.*

Culture No.	Proportions and actual amount.			Actual amounts of fertilizers.					
				Ammonium set.			Nitrate set.		
	K	N	P	Potassium sulphate.	Ammonium sulphate.	Double superphosphate.	Potassium sulphate.	Sodium nitrate.	Double superphosphate.
	gm.	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*
1	1	1	20	2.5	8.7	94.0	2.5	8.8	94.0
2	1	5	15	2.5	43.5	70.5	2.5	44.0	70.5
3	1	15	5	2.5	130.5	23 5	2.5	132.0	23.5
4	1	20	1	2.5	174.0	4.7	2.5	176.0	4.7
5	5	1	15	12 5	8 7	70.5	12.5	8.8	70 5
6	5	15	1	12 5	130.5	4.7	12.5	132.0	4.7
7	15	1	5	37.5	8 7	23.5	37.5	8.8	23.5
8	15	5	1	37.5	43 5	4.7	37.5	44.0	4.7
9	20	1	1	50.0	8 7	4.7	50.0	8.8	4 7
Control	0	0	0	0	0	0	0	0	0

TABLE IV.—*The sum of all numerical data for the sodium nitrate and ammonium sulphate series*

Culture No.	Ammonium sulphate series.		Sodium nitrate series.	
	Actual.	Corrected.	Actual.	Corrected
1	7550	10066	7145	9593
2	7699	10265	3599	7197
3	9146	12194	1597	3193
4	13046	13046	827	3308
5	10206	10206	1063	1417
6	17269	17269	2905	3873
7	6870	6870	5262	5262
8	8212	8212	5252	7003
9	6324	6324	2707	3609
Control	4501		4501	

TABLE III.—*Numerical data for the triplicate sets of cultures of the abaca plants (Series I) supplied with a 3-salt culture solution.*

Culture No.	Salt proportions.			Height of tallest leaf in cm			Green weight of top in grams.			Approximate area of leaves sq. cm.			Number of roots.			Total.	
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$	a	b	c	a	b	c	a	b	c	a	b	c	Actual	Corrected.
1	1	1	10	*a*	16	20	*a*	7	12	*a*	88	253	*a*	11	9	416	554
2	1	4	7	*a*	29	21	*a*	22	11	*a*	431	216	*a*	15	7	752	1035
3	1	7	4	8	23	22	1	14	16	46	318	292	6	10	10	766	766
4	1	10	1	15	22	*a*	4	12	*a*	106	310	*a*	7	8	*a*	484	645
5	2	2	8	25	26	21	22	15	13	415	323	359	11	11	10	1230	1230
6	2	5	5	29	17	*a*	31	14	*a*	630	165	*a*	10	10	*a*	906.	1208
7	2	8	2	25	31	20	25	28	11	405	561	688	15	15	11	1835	1835
8	3	3	6	22	24	25	10	15	27	262	440	476	10	11	11	1333	1333
9	4	1	7	19	29	21	12	21	12	276	451	241	13	8	8	1111	1111
10	4	4	4	21	34	25	10	41	11	242	701	356	11	15	8	1475	1475
11	4	7	1	23	29	27	19	19	25	428	394	531	12	9	15	1531	1531
12	5	2	5	17	27	*a*	12	21	*a*	215	335	*a*	11	13	*a*	651	868
13	5	5	2	*a*	25	27	*a*	21	18	*a*	442	296	*a*	12	10	851	1134
14	6	3	3	*a*	16	24	*a*	5	17	*a*	161	372	*a*	5	13	613	814
15	7	1	4	27	18	21	19	4	9	366	112	422	9	12	8	997	997
16	7	4	1	14	11	25	3	2	15	114	56	430	9	7	9	695	695
17	8	2	2	24	30	15	12	31	7	346	616	178	8	11	9	1311	1311
18	10	1	1	19	23	28	10	14	24	304	457	737	6	8	11	1641	1641
19	Control			19	18	15	7	8	6	217	220	160	6	11	8	695	695

a The plant died Nothing was harvested

FOLIAR TRANSPIRING POWER OF DIFFERENT VARIETIES OF ABACA GROWN AT THE COLLEGE OF AGRICULTURE [1]

By PERPETUO GAVARRA AND R. B. ESPINO

WITH TWO TEXT FIGURES

This paper presents the first set of results obtained from a series of studies in finding the varieties of abaca, grown in the College of Agriculture, in Los Baños, that might be best adapted to a region having prolonged drought. The conclusion that may be derived from the present study, although valuable, is not comprehensive as only twelve varieties were investigated. The method employed is known as the cobalt-chloride test for the determination of the transpiring power or the natural ability of the leaf of plant to give off water vapor in spite of the absence of influence of some of the factors in the environment of the plant.

EXPERIMENTAL PROCEDURE AND RESULTS

The varieties of abaca (*Musa textilis*) used were Maguindanao, Tañgoñgon, Pulahan, Libuton, Boñgulanon, Punacan, Baguisanon-Basag, Baguisanon-Lawaan, Sinaba, Agutay, Putian, and Itom.

A fully grown stalk of each of the twelve varieties under observation was used. In testing the foliar transpiring power, a cobalt-chloride slip about 30 millimeters in width was placed in contact with the upper or lower surface. Five tests were made on the upper surface of every leaf of each plant,—from the oldest to the youngest. In each test the time-period was recorded with the use of a stop-watch and the temperature with a thermometer. Before making the tests in this study the cobalt-chloride slips were standardized in the laboratory. Since the slips here employed were all from a rather large piece of filter paper impregnated with the salt it was not surprising, as was found, that they had the same coefficient.

By Livingston (1) and others the final result of each test is called the *index of transpiring power* of the leaf. By this is meant the power of the leaf surface to give up water vapor compared with a similar power of the standard water surface, that is, the time period required to effect a color change of the cobalt-chloride slip placed over a standard evaporating surface (water-saturated porous clay covered with a millimeter of air) divided by the length of time required to make the change of color of the same slip when placed upon the surface of a leaf of the same temperature. In this experiment the temperature of the air in the laboratory when the standardization of the slips was made was not the same as that observed around the leaf; it was, therefore, necessary that the equivalent vapor-pressure of water shown in a table published by Livingston and Shreve (2) be employed in the computation of the index of the transpiring power sought.

How the computations were made are described by Trelease (3) as follows:

> In one of the tests, for a certain slip of cobalt paper the time-period for the color change on the leaf was 77 seconds when the air temperature was 23.7° C., corresponding to a vapor pressure of water of 21.76 millimeters. Since the slip of cobalt paper had required 31.9

[1] Thesis presented for graduation from the College of Agriculture, No. 155, Experiment Station contribution, No. 127.

seconds for the change over the standard surface when the temperature was 27.4° C., corresponding to a vapor pressure of 27.10 millimeters, the time-period required for the change over the standard surface at the temperature of the leaf would have been $31.9 \times 21.10 \div 21.76$, or 40 seconds. In this test the index of transpiring power, being the time required for the change over the standard surface divided by the time required for the change over the leaf at the same temperature, was 40 divided by 77 or 0.52.

The numerical data on the relative ability of the upper and the lower epidermis of each of the leaves on one mature plant of each of the abaca varieties studied, with the corresponding air temperature during the experiment are not here given.

But the method of computation as quoted from Trelease was followed and the data of the *index of foliar transpiring power* obtained are given in Table I only as averages of similar data, that is, from the quintuplicate trials as well as the average of the data for the upper and lower epidermis of the same leaf. Likewise, the averages for all the leaves (upper and lower) on each of the plants studied are shown in the same table. These averages for different varieties studied are graphed in Figure 1.

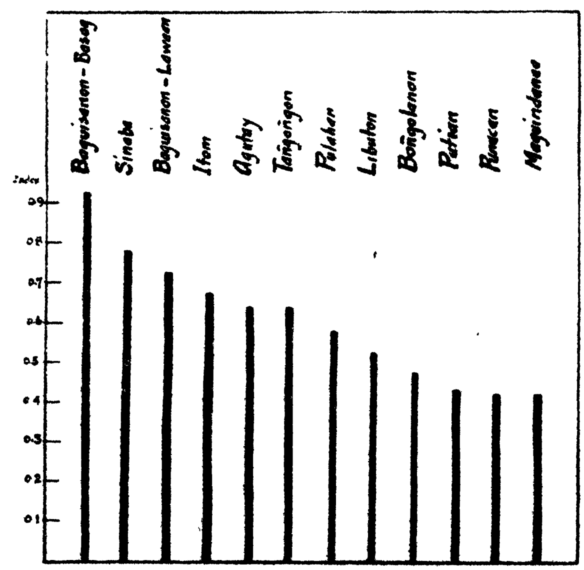

Figure 1. Showing the comparative foliar transpiring power (average of averages) of the different varieties of abaca studied; arranged in the descending order.

The bi-hourly march of the transpiring power of a middle-age leaf of abaca, variety Libuton, was also determined. The tests were from six o'clock in the morning one day until six in the morning of the next. Five readings were taken

within each bi-hourly period of observation. The *index of the foliar transpiring power* as computed and the averages together with the records of the *transpiring power* of air are graphed in Figure 2.

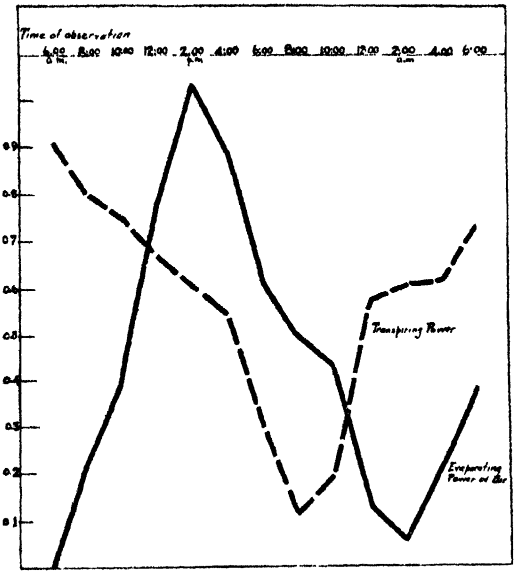

Figure 2. Bi-hourly march of foliar transpiring power of Libuton variety of abaca compared with the records of evaporation.

DISCUSSION OF RESULTS

Accepting the idea with many investigators that the index of transpiring power as put forward by Livingston (1) is a measure of the power of leaves to supply moisture to the surrounding air, and considering as correct the belief that "the reciprocal of this index is a measure of the power of leaves to retain water against the drying influence of the surroundings" (4), it may follow, therefore, that the data on hand found with the use of the cobalt-chloride method may lead to the discovery of the relative resistance to drought of the varieties studied. With this idea in mind and considering the results in terms of averages, we may now begin to examine the data on hand. Care is taken in this report not to go into minute details because a certain amount of the human factor or equation is partly responsible for slight discrepancies that may be found in the data on hand.

Examining the data in Table I we find that the indices of foliar transpiring power of all the varieties studied are from about two to about five times higher in the lower leaf epidermis than in the upper epidermis. This difference is no doubt due to the presence of either all, or most, of the stomata in the lower surface of the leaf of abaca.

The data in Table I seem not to warrant a generalization as regards the relative transpiring power of the leaves of different ages of each plant. For in some varieties the transpiring power increased as the youngest visible leaf was approached. In others, however, the reverse was observed. As regards the average of averages of results shown in Table I and graphed in Figure 1, it is interesting to note that the varieties Baguisanon-Basag, Sinaba and Baguisanon-Lawaan showed a transpiring power relatively greater than in the other varieties. The varieties Boñgulanon, Putian, Punacan, and Maguindanao have the lowest record. In accordance with our working theory, the last four varieties mentioned have relatively the greater power to retain water against the drying influence of the environment. From this characteristic it may follow that these varieties might be suitable for planting in places where the drying influence of the air is great.

But the Maguindanao has been reported by Aldaba (5) as "easily injured by prolonged dry weather". It becomes now necessary to attempt to explain the two apparently contradictory facts.

The Maguindanao variety has mature leaves larger and broader than those of any of the varieties studied. In point of number it is one of the varieties that have the greatest. Its surface of exposure, then, is relatively large. For this reason, although it possesses a relatively low index of foliar transpiring power, the total amount of water that leaves its body is correspondingly large. This fact together with our knowledge that the plant possesses a scanty root system is probably mainly responsible for the failure of the variety to withstand prolonged dry weather. The other varieties are not defective in their root system. Their respective *index* as graphically illustrated in Figure 1 may serve as a guide of their relative drought-resistance. The varieties Itom, Agutay, Tañgoñgon, Pulahan and Libuton are neither too free nor too conservative in giving off water in the air. For this reason they may be adaptable to places where extremes of weather are not experienced.

The bi-hourly march of foliar transpiring power of the twelve varieties has also been studied. Graphs in Figure 2 show that the *index* was highest during the very early morning hours. It gradually fell until eight o'clock in the evening, at which time it began to rise again until the early hours of the next day. Compared with the *evaporating power of the air* (see Fig. 2) its rate was almost inversely proportional. The highest record for evaporation, however, was obtained durng the very early afternoon hours and the lowest was at two o'clock in the morning Since the records for the evaporation of the present study are about the same as obtained by Trelease (3) in his study of the transpiring power of the leaves of the coconut on the College Campus and since the curve for the transpiring power of the leaves of abaca fits quite closely a similar curve for the coconut, the two plants would seem to be similar in this respect. Their graphs of the hourly (bi-hourly in the case of abaca) march of transpiring power resemble in a general way similar graphs for other kinds of plants studied by the cobalt-chloride method.[2]

[2] See Bakke (5); Trelease (4); Trelease and Livingston (7); Bakke and Livingston (8).

SUMMARY OF CONCLUSIONS

(1) The present study should be considered as only preliminary in nature. A much more thorough study should be made on the transpiring power of the leaves of abaca of the different varieties under different climatic conditions.

(2) The index of foliar transpiring power of the twelve varieties of abaca studied was from about two to about five times greater for the lower surface than for the upper surface.

(3) Due to some disagreement in the numerical data obtained, further experiments should be made on the relative rate of transpiring power of the different leaves of each plant.

(4) The Baguisanon-Basag, Sinaba and Baguisanon-Lawaan varieties had the highest *index of transpiring power*. The varieties Boñgulanon, Putian, Punacan and Maguindanao had the lowest *index*.

(5) The first three varieties in (4) may be considered as relatively the least resistant to drying influence of the environment. With the exception of Maguindanao the last four varieties may be resistant to drought. In the field the Maguindanao variety has been found not resistant to the drying influence of the weather. This is due to a large crown and a limited root-system, conditions which are not found in most of the abaca varieties known.

(6) The march of the transpiring power during the day of a full grown leaf of the Libuton variety seems to agree with that of the coconut palm both in rate and in fluctuations.

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TABLE I.—*Averages of several similar data on the index of foliar transpiring power of abacas.*

Leaf No.	Names of Varieties.								
	(a) Maguindanao.			(b) Tañgoñgon.			(c) Pulahan.		
	Upper surfaces.	Lower surfaces.	Average of two sides.	Upper surfaces.	Lower surfaces.	Average of two sides.	Upper surfaces.	Lower surfaces.	Average of two sides.
I	0.23	0.45	0.34	0.266	0.874	0.57	0.336	0.71	0.523
II	0.22	0.432	0.326	0.20	0.974	0.587	0.252	0.874	0.563
III	0.24	0.528	0.284	0.216	1.00	0.608	0.25	0.896	0.573
IV	0.276	0.828	0.552	0.31	0.994	0.652	0.306	0.952	0.629
V	0.346	0.996	0.671				0.30	1.004	0.652
Averages for all the leaves.			0.435			0.604			0.588
	(d) Libuton.			(e) Boñgulanon			(f) Punacan.		
I	0.158	1.098	0.608	0.16	0.664	0.412	0.176	0 582	0.374
II	0.312	0.722	0.517	0.16	0.708	0.434	0.202	0.728	0.465
III	0.164	1.098	0.631	0.152	0.576	0.364	0.256	0.552	0.402
IV	0.236	0.938	0.587	0.188	0.954	0.571	0.236	0.668	0.452
V				0.222	1.038	0.530	0.224	0.668	0.496
Averages for all the leaves.			0.588			0.462			0.439
	(g) Baguisanon-Basag.			(h) Baguisanon-Lawaan.			(i) Sinaba.		
I	0.324	1.706	1.015	0.314	1.475	0.894	0.322	1.594	0.958
II	0.35	1.538	0.944	0.296	1.412	0.854	0.32	1.426	0.873
III	0.302	1.582	0.942	0.30	1.498	0.899	0.296	1.572	0.934
IV	0.266	1.216	0.736	0.30	1.432	0.866	0.32	1.53	0.925
V							0 30	1.504	0.902
Averages for all the leaves.			0.703			0.703			0.798
	(j) Agutay.			(k) Putian.			(l) Itom.		
I	0.428	0.886	0.657	0.334	0.816	0.574	0.206	1.184	0.695
II	0.302	0.96	0.631	0.242	0.634	0.438	0.202	1.03	0.616
III	0.346	0.984	0.665	0.252	0.658	0.455	0.218	1.086	0.552
IV	0.296	1.236	0.766	0.238	0.556	0.397	0.286	1.19	0.738
V	0.28	0.72	0.50	0.218	0.484	0.356	0.256	1.242	0.749
Averages for all the leaves.			0.643			0.443			0.670

COMPARATIVE STUDY OF FIBERS PRODUCED BY SIX VARIETIES OF ABACA WHEN GROWN IN LOS BAÑOS: I[1]

By R. B. ESPINO and FELIX ESGUERRA

WITH SEVEN PLATES

There are about one hundred varieties of the abaca plant growing in different parts of the Archipelago. Some seventy of these varieties are now under culture at this College. Most of these varieties had been fruiting for more than a year and were, therefore, suitable for such a study as is here reported.

The present study deals mainly with the microscopical structures of the fibers and fiber-cells in the leaf-sheaths from the stalks of six varieties of abaca. It also deals with the comparative strength of the fibers from these varieties. The primary object was (1) to establish any striking peculiarities of the fibers of the different varieties and (2) to compare the strength of the fibers from the different varieties when grown side by side under Los Baños conditions of soil and climate. The results from this study may be of value in the determination, not only of the comparative merits of the varieties as regards the yield of fiber, but also in the establishment of a permanent system of varietal nomenclature.

This study was carried out at the College of Agriculture, Los Baños, during the college year 1921-1922.

MATERIALS, METHODS AND RESULTS

VARIETIES USED

The varieties used in this study were: Boñgulanon, Itom, Libuton, Maguindanao, Punucan, and Sinaba. These are grown side by side in the Lower Nursery of the College. From Vista's (1) description, the following is quoted:

a. *Musa textilis Née. Var. Boñgulanon (Saleeby) C. A. 1020.*—Produces 15-29 plants to a hill, but 4-10 are medium and 10-15 are small, somewhat spreading in the hill, fast grower, generally inclined to lowland habitat. False stem is 3.7-4.6 m. high, 15-20 cm. diameter at base and 8.9-10 cm. diameter at top.

This variety is from La Carlota Experiment Station. It is rarely found outside of Mindanao. Edwards and Saleeby (2) pointed out that it has very white, strong, heavy, and easy to extract, fibers.

b. *Musa textilis Née. Var. Itom in Albay, Samorong Itom in Ambos Camarines. C. A. 4293.*—Producing 3-8 plants in a hill but 1-2 are medium and 1-3 are small, somewhat spreading in the hill; fast grower, generally erect. In the College Nursery this variety produces 30-35 plants but 5-10 are medium and 10-15 small ones which are crowded in the hill. False stalk is 3.34-4.50 m. high, 16-20 cm. diameter at enlarged base and 11.14 cm. diameter at top.

This variety is from Lamao Experiment Station. It is considered one of the best varieties in Albay, for it produces good and strong fibers.

c. *Musa textilis Née Var. Maguindanao (Saleeby).*—Produces 10-17 plants to a hill but 4-5 are medium and 4-8 are small, spreading in the hill; fast grower, began flowering at the age of 1 year and 4½ months after the sucker is transplanted, of lowland habitat. False stem is 3.30-4.30 m. high, 20-22 cm. diameter at enlarged base and 8-12 cm. diameter at top; this grows into a very big plant and as tall as 5.5 m. if planted on rich alluvial soil but it flowers when only 2.5 m. high if grown on heavy soils. This variety is from Lamao Experiment Station.

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[1] Thesis presented for graduation from the College of Agriculture, No. 156; Experiment Station contribution No. 128.

This variety is cultivated throughout Davao. It produces few roots so it is easily affected by drought and easily fallen by wind.

d. Musa textilis Née Var. Libuton (Saleeby) C. A. 100.—Produces 3-6 suckers per hill, but 1-2 are small, crowded in the hill; erect, fast and hardy growers. False stem 3.75-4.75 m. high, 16-20 cm. diameter at enlarged base and 10-11 cm. diameter at top.

This variety is from Mindanao. Its fiber is lighter than those of Boñgulanon, Maguindanao and Tañgongon; so it is not very popular. It is an early variety bearing flowers at the age of 14½ months.

The two other varieties were not studied by Vista but were described by Edwards and Saleeby (2).

Their description, together with the results of our observation on these two varieties at the College, will give the following characteristics:

e. Musa textilis Nee Var. Punucan.—C. A. 10276. This variety is exactly like Libuton in all characteristics, with the exception of color and the number of stalks in a hill. It is often mistaken for Libuton.

In the College Nursery, this variety produces 6 t 10 plants in a hill, but 3 to 4 are medium, and 3 to 6 are small; generally erect. False stalk is 2.6 to 2.8 meters high, 13 to 15 centimeters in diameter at the enlarged base and 7 to 9 centimeters in diameter at the top.

This variety is from La Carlota Experiment Station.

f. Musa textilis Nee Var. Sinaba, C. A. 10310.—The thickness of the stalk compares favorably with that of Libuton but is shorter.

In the College Nursery, this variety produces 8 to 12 stalks per hill; 4 to 5 are medium and 4 to 7 are small. False stalk is 2.4 to 2.7 meters high, 14 to 16 centimeters in diameter at enlarged base and 6 to 9 centimeters in diameter at the top.

This variety is from La Carlota Experiment Station.

MICROSCOPIC STUDY

Microtome sections were made from the outermost leaf-sheaths one-half meter from the base and two centimeters from either edge. The different types of fibers found in the section were drawn with the aid of a camera lucida. The drawings are shown in Plates I to VI.

Also, with the aid of a camera lucida and after maceration, cells obtained from the fibers (1) either at edge of the outermost leaf-sheath, (2) near the outer epidermis two centimeters from the edge, (3) from the "bridge", and (4) from the inner epidermis of the sheath, were drawn longitudinally. The dimensions of these cells were measured, but the numerical data are not here published. Plate VII shows a portion of median longitudinal sections of fiber-cells. Average dimensions of fiber-cells are given in Table I.

GROSS AREA OF FIBER STRANDS

The gross cross-sectional area of each of the fiber strands drawn and obtained from the different varieties studied was determined with the use of a planimeter. The data are given in Table II.

TENSILE STRENGTH OF FIBERS

Materials used.—The fibers from the edges and middle portion of each of the sheaths from the largest fruiting stalk of each variety were extracted with the use of an ordinary stripping machine. The fibers were dried in the air and their tensile strength determined.

The tests.—An apparatus, similar to the one employed by Espino (3), was used in testing the tensile strength of each sample which consisted of five fibers, 50 centimeters long. One end of each sample was attached to a clamp at the upper end of the apparatus; to the lower end of the sample, another clamp was attached. To this end, weights were gradually added. The smallest weights used were small lead shot. When the samples were about to break, care was taken to increase the load by adding shot one by one. Only the tests where the break of the fibers occurred simultaneously and somewhere between the two ends of the sample, were considered good; the others were discarded. The weight of the sample of fiber in each good test was determined. The breaking stretch of each sample of fiber was also recorded. The records of the actual breaking strength, as well as those of the computed tensile strength, of each sample from the six varieties were secured. But only the data in terms of averages are here published (see Table III.) The tensile strengths (averages) of the fiber samples reduced to a gram basis are presented in Table IV. The data on the average breaking stretch of fibers from the middle and edges of each leaf-sheath are given in Table V.

DISCUSSION OF RESULTS

THE FIBER STRANDS

Comparative gross area.—As shown in Table II the cross-sectional areas of different fiber structures in different parts of a leaf-sheath differ from one another considerably. The smallest fiber strand recorded in the table had a cross-sectional area of 0.0003 square millimeter and the largest was 0.00031 square millimeter. The fiber strands composed of purely sclerenchymatous cells are usually much smaller than those with conducting structures. The first six strands in Table II are purely sclerenchymatous cells. Strands No. 7 had very little conducting tissues, and as reported by Espino (3) are the largest solid fiber obtained in stripping.

Comparing the total cross-sectional areas of the six varieties, the Boñgulanon, Sinaba, and possibly the Libuton, had the largest. The smallest area was obtained from Itom. This same order of results was obtained after taking the total area of the first seven strands in each variety. It is obvious (considering only the fibers that usually come out solid, not broken after stripping) that the Boñgulanon, Sinaba and the Libuton varieties produce coarser fibers than the Itom, Maguindanao and the Punucan varieties. Boñgulanon fibers were the coarsest and those of Itom were the finest.

Appearance in cross-section.—Upon examination of Plates I to VI it may be seen that Figures 1 to 6, inclusive, in each plate, are drawings of the cross-sections of purely sclerenchymatous strands. These, together with strands shown in Figure 7, constitute the bulk of the fibers found in the market. The sclerenchyma strand near the phloem portion of the vascular bundle, Figure 8, is usually broken into two or more pieces in stripping. In the market, these pieces were found by Espino mixed with the purely sclerenchyma fibers. The fiber strands, which in part, form the big vascular bundles at the "bridge," or in the inner portion of the leaf-sheath, (Figs. 8 to 11), are usually thrown away with the waste in stripping. The fiber-cells constituting these strands are relatively large and have comparatively large lumina and thin walls. Moreover, as shown in the

figures the sclerenchyma strands in each vascular bundle are of crescent shape. They are not cylindrical in cross section. They are, therefore, as reported by Espino and as observed in this study, weak fibers,

Of the six varieties studied, the fiber-cells from Sinaba have strikingly large lumina. The fiber-cells of the Boñgulanon, on the other hand, are provided with apparently relatively thick walls and very narrow lumina The fibers from the other four varieties are of the same general apperance, as seen in cross section.

THE FIBER-CELLS

The length.—Table I shows that the fiber-cells from the edges or near the edges of the leaf sheath of each of the Boñgulanon, Maguindanao, Punucan, and Sinaba varieties are shorter than the fiber-cells of the same variety but obtained from the so-called *discarded portion* of the leaf-sheath. In Table I the records representing the fiber-elements from the discarded portion are those that were obtained from the "bridge" and from the portion of the sheath near the inner epidermis.

The average lengths of the fiber-cells obtained from the different parts of a leaf-sheath of Libuton are about the same. The same is true with the fiber-cells of Itom.

Considering the average length of the fiber-cells of the leaf-sheath, Punucan had the shortest, being about 2.6 millimeters. The Boñgulanon had the longest fiber-cells, 5.3 millimeters. This was followed by Itom. The average lengths of the fibers of Libuton, Maguindanao, and Sinaba were about the same.

Gross diameter.—Considering only the fiber-cells from the edges and near the edges of the leaf-sheath, the largest gross diameter (average) of fiber-cells was obtained from the fibers of Boñgulanon. It was 0.0196 millimeter. The next in size of gross diameter was of Itom. It had 0.0142 millimeter as an average of ten measurements. The diameters of the fiber-elements of the other varieties stand between the maximum (0.0196 millimeter) and the minimum (0.0142 millimeter) here reported.

Thickness of walls.—The thickness of the walls of the cells from the edges and near the edges is considerably greater than the thickness of the walls of the fiber-elements from the *discarded portion* of the leaf-sheath. This is true in all the varieties here reported. This fact in part accounts for the relative weakness of the fibers in the *discarded portion* of the leaf-sheath.

On an average, the Boñgulanon had the thickest walls of the fiber elements. The maximum thickness was 0.00801 millimeter. The thinnest wall was found in Sinaba fibers, 0.004795 millimeter in the fibers obtained from near the outer epidermis about two or three centimeters from the edges of the leaf-sheath.

Diameter of lumen.—The data in Table I conclusively show that the fiber-cells from the *discarded portion* of the leaf-sheath (C and D in the table) have the widest diameter of the lumen. The maximum recorded is 0.02765 millimeter and the minimum is 0.0132 millimeter.

The diameters of the lumina of the fiber-elements found in the portion of the leaf-sheath that gives good fiber were found only 0.0078 millimeter as the maximum, and 0.00257 millimeter the minimum. These data are also shown in Table I. This table further shows that Itom and Sinaba had the widest lumina of all the varieties studied. The Boñgulanon possesses fiber-cells with particularly

narrow lumina. In terms of average of ten measurements, the lumina of fiber-cells from the edge of the leaf-sheath of Boñgulanon had a diameter of 0.00275 millimeter only.

TENSILE STRENGTH OF FIBERS

The actual data.—By actual tensile strength of fibers is here meant the weight that will be required to break samples consisting of five average-sized fibers, 50 centimeters in length.

All the tensile strength tests made on fibers obtained from the different leaf-sheaths of each variety show that the fibers from the four or five leaf-sheaths somewhere between the outermost and the innermost leaf-sheaths of one trunk were the strongest. Espino in 1915 obtained similar results and had explained the case by assuming that the fibers from the few outermost leaf-sheaths were relatively brittle due to a more thorough impregnation of silica and other substances in the walls of the fiber-elements. Such impregnation of silica makes the fiber relatively weak. On the other hand, the fibers from the few innermost leaf-sheaths of each trunk are finer than those from the outer leaf-sheaths. The cell walls are probably not thoroughly developed or lignified.

Table IV shows that the fibers from the middle (or midrib) portion of the leaf-sheath were invariably stronger than those from the edges. As will be seen in the latter part of this paper, this difference was due to the difference in the weights of the sample from the edges and those from the midrib. The fibers from the midrib were coarser and consequently heavier and had probably a greater cross-sectional area of walls than the fibers from the edges. But when the records of strength of the fibers were reduced to a gram basis, as will be seen, the fibers from the edges come out stronger.

As was to be expected on account of the extraordinary thickness of the walls and narrow lumina of the fiber-elements in the Boñgulanon, this variety, of all the varieties tested, produced the strongest fibers. The strongest sample of fiber from this variety required a weight of 17.47 kilograms to break it. The average of averages of fibers from the edges and those from the middle portion of the leaf-sheath was 9.86 kilograms for Boñgulanon, 8.22 kilograms for Sinaba, 7.88 for Libuton and a little over 6.5 kilograms for each of the remaining four varieties.

Incidentally, it should be remarked that the Boñgulanon had the most leaf-sheaths; leaf-sheaths that produced fibers that could be tested. The Sinaba fibers, although relatively strong, are produced from only 14 leaf-sheaths. The rest of the varieties studied had about an equal number of leaf-sheaths from one stalk.

The calculated data.—As stated in the preceding paragraph, if the breaking load were computed to one-gram sample, the fibers from the edges would, as was experienced by Espino, come out stronger than those from the midrib of each leaf-sheath. Evidently this expectation was fulfilled as shown by the data in Table IV. Inspection of this table shows that the Sinaba fibers were the strongest of the lot. The average strength (119.71 kilograms) was, however, only a little stronger than Punucan fibers (119.3 kilograms). Itom, Libuton, and Maguindanao produced fibers of about the same average strength. In terms of one-gram samples the fibers of Boñgulanon gave an average strength of 104.84 kilograms, only. This variety, then, had the weakest fibers in this respect.

Table IV further shows that the fibers obtained from a few leaf-sheaths somewhere between the outermost and the innermost leaf-sheaths were the strongest. This result points out the special preference or suitability for cordage purposes of the fibers from the few inner leaf-sheaths referred to.

BREAKING STRETCH OF FIBERS

Table V shows that the records of the breaking stretch of fibers obtained from the different leaf-sheaths of one stalk of each of the varieties studied do not differ much from one another. However, the breaking stretch of the fibers extracted from the two or three outermost leaf-sheaths as well as the breaking stretch of about the same number of innermost leaf-sheaths was almost always shorter than that for the outermost and the innermost leaf-sheaths.

The general close similarity of the data in the table seems to suggest either that the fibers of the different varieties have about the same stretching power, or that the method used for recording or testing the stretch needs improvement. Further studies should be carried out before any safe generalization can be drawn on the comparative stretch of fibers from the different leaf-sheaths in one stalk or from stalks of different varieties of abaca.

SUMMARY OF CONCLUSIONS

From the results obtained in this study, the following conclusions may be drawn:

1. The Boñgulanon and Sinaba varieties had relatively coarse fibers. With these two varieties, Libuton may be included. Itom had relatively fine fiber.
2. Boñgulanon had the longest fiber-cells; Punucan, the shortest, considering only the fibers at the edges of near the edges of the leaf-sheath.
3. Boñgulanon had the widest fiber-cells, followed by Itom; Punucan had the smallest. The other varieties had about the same, a size intermediate between Boñgulanon and Punucan.
4. The walls of the fiber-cells near the outer epidermis were very much thicker than those of fibers from the *discarded portion*. Boñgulanon had the thickest walls and Sinaba, the thinnest.
5. The lumina of fiber-cells from the so-called *discarded portion* of the leaf sheath had the widest diameter. The fiber elements of Boñgulanon had relatively narrow lumina.
6. The fibers from the outermost and innermost leaf-sheaths were weaker than those from the leaf-sheaths lying between. Boñgulanon fiber was the strongest in terms of actual breaking load. Sinaba fiber was next in strength, Itom had the weakest. When the strength of the fiber was considered in terms of a unit weight of the sample, Sinaba and Punucan fibers were the strongest and Boñgulanon the weakest.
7. A more satisfactory method of recording the tensile stretch of fibers should be devised.

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(2) EDWARDS, H. T., and SALEEBY, M. M. Abaca (Manila hemp) Farmers Bulletin, 12: 15-17, 1910.

(3) ESPINO, R. B. Abaca fiber. Philippine Agriculturist and Forester 4: 200-207, 1915.

ILLUSTRATIONS

PLATE I

Cross section of fibers from Boñgulanon variety of abaca.

PLATE II

Cross section of fibers from Itom variety of abaca.

PLATE III

Cross section of fibers from Libuton variety of abaca.

PLATE IV

Cross section of fibers from Maguindanao variety of abaca.

PLATE V

Cross section of fibers from Punucan variety of abaca.

PLATE VI

Cross section of fibers from Sinaba variety of abaca.

Each plate has 13 or 14 figures as follows:

Figs. 1 to 8. Fibers between the bridge and the outer epidermis.
Figs. 9 to 10. Fibers at "bridge".
Fig. 11. Fiber at "bridge" extending downwards.
Figs 12 to 13 or 14. Fibers between "bridge" and inner epidermis.

PLATE VII

Portions of the fiber cells from different varieties of abaca.

A. Cells from fibers at either edge of the outermost leaf-sheath.
B. Cells from fibers near the outer epidermis two centimeters from the edge.
C. Cells from fibers at bridge
D. Cells from fibers obtained near the inner epidermis.

TABLE I.—*Average dimensions of fiber-cells.*

Origin of fiber-cell.	Variety name.	Dimensions of fiber-cells. Gross diameter.	Diameter of lumen.	Thickness of cell wall.	Length.
		mm.	*mm.*	*mm.*	*mm.*
A. From edges of leaf sheaths	Boñgulanon.	.0180	.00275	.007625	5.229
	Itom.	.0149	.00620	.005750	5.226
	Libuton.	.0177	.00257	.006115	4.676
	Maguindanao.	.01535	.00295	.006200	4.528
	Punucan.	.0142	.00285	.005725	2.591
	Sinaba	01408	.00340	.005340	4.324
B. From outer epidermis, one inch from edges	Boñgulanon.	.0196	.00358	.008010	5.308
	Itom.	.0172	.00715	.004975	4.975
	Libuton	.01645	.00505	.005600	3.857
	Maguindanao.	.02525	.00453	.005360	3.821
	Punucan.	.01450	00372	005390	3.170
	Sinaba	.0174	.00780	.004795	3.204
C. From "bridge"	Boñgulanon.	.02250	.01320	.004650	6.997
	Itom.	.02180	.01305	.004375	4.981
	Libuton.	03300	.02405	.004525	4.481
	Maguindanao.	02370	.01650	003600	6.162
	Punucan.	02870	.02145	.003625	6.091
	Sinaba	.02430	.01675	.003675	6.184
D. From portion near inner epidermis	Boñgulanon.	02320	.01325	.004975	7.377
	Itom.	.02820	.02165	.003275	5.120
	Libuton	.02820	.02090	.003650	4.834
	Maguindanao.	.03500	.02765	.003675	8.398
	Punucan.	.02900	.02250	.003250	7.198
	Sinaba	.02192	01530	.003305	6.140

TABLE II.—*Cross sectional area of schrenchyma strands obtained from different parts of a sheath of each of six varieties of abaca.*

Strand No.	Bonñgulanon	Libuton.	Maguindanao	Itom.	Sinaba.	Punucan.
	sq. mm.	*sq. mm.*	*sq. mm.*	*sq. mm.*	*sq. mm.*	*sq. mm.*
1	.00048	.00051	.00128	.00033	.00048	.00031
2	00051	.00061	.00159	.00048	.00106	.00061
3	.00316	.00214	.00173	.00049	.00122	.00112
4	.00485	.00353	.00616	.00088	.00267	.00265
5	.01612	.00763	.01371	.00158	.00716	.00869
6	.05469	.04110	.02622	.02204	.05216	.02982
7	.06477	.05102	.04143	.02323	.06214	.03214
8	.05243	05283	02733	.02884	.05408	.03674
9	.03918	.01355	.00571	.00747	.01306	.01049
10	.05804	.05541	.03535	.04888	.05302	.03953
11	.05173	.04871	.04498	.05720	.06224	.03761
12	.01429	.00261	.00279	.00133	.00787	.00694
13	.00526	.00673	.00302	.00343	.00953	.00504
Total	.36551	.28638	.21130	.19618	.32669	.21089
Total from 1-7 incl.	.14458	.10554	.09212	.04903	.12689	.07534
Total from 8-13 incl.	..22093	.188084	.11918	.14715	.19980	.13535

TABLE III.—*Average of tensile strength tests consisting of five fibers, each 50 centimeters in length.*

Leaf-sheath No.	Boñgulanon.		Itom.		Libuton.		Maguindanao.		Punucan.		Sinaba.	
	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.
	kg.	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*
1	11.96	8.52	7.95	4.99	8.15	7.03	6.95	4.95	7.70	6.00	10.96	6.98
2	11.76	8.30	—	7.58	10.10	6.83	6.46	5.74	8.27	5.19	11.20	7.49
3	11.62	8.60	8.91	7.17	9.62	8.03	7.93	5.52	8.61	6.99	10.53	8.78
4	10.78	8.80	—	6.13	12.35	7.96	7.63	5.96	9.34	6.46	11.50	8.67
5	13.35	9.09	11.19	6.94	9.54	6.79	8.25	6.20	10.22	6.31	12.22	7.88
6	13.24	8.38	10.88	5.64	11.88	6.99	9.05	7.51	10.92	6.59	13.35	7.72
7	13.52	9.00	12.10	6.55	11.27	8.74	10.62	7.14	8.75	7.54	9.64	8.85
8	14.55	8.53	9.32	6.21	12.40	8.57	11.73	7.89	9.79	7.38	11.15	7.78
9	15.46	11.54	11.00	7.13	10.79	7.45	12.73	8.40	9.19	5.75	10.55	6.89
10	17.47	9.73	9.00	6.93	9.61	7.11	11.84	7.91	7.52	6.36	9.22	5.95
11	13.53	7.72	8.92	6.30	10.12	6.06	7.95	6.65	8.43	5.62	6.67	5.65
12	15.49	8.75	8.54	5.36	9.54	8.32	6.44	6.48	7.48	5.33	6.86	4.40
13	12.71	9.06	6.53	5.25	9.42	8.09	9.56	5.22	6.89	4.88	7.09	4.59
14	11.64	9.19	5.65	4.29	8.84	6.49	7.54	5.74	7.33	4.68	5.10	2.58
15	11.74	7.19	5.80	2.40	7.64	5.52	5.02	6.52	6.87	4.50	—	—
16	10.87	7.40	2.90	2.91	5.39	3.20	5.94	4.38	3.94	3.60	—	—
17	9.56	5.67	2.37	2.97	8.02	4.80	4.56	4.81	2.82	2.13	—	—
18	10.80	3.95	2.11	3.02	5.21	4.48	4.23	4.14	—	—	—	—
19	8.78	4.19	—	—	4.12	2.86	3.26	3.57	—	—	—	—
20	8.50	6.26	—	—	—	—	3.57	3.46	—	—	—	—
21	3.82	3.07	—	—	—	—	—	—	—	—	—	—
Average	11.96	7.76	7.70	5.43	9.16	6.60	7.56	5.91	7.89	5.61	9.72	6.73
Average	9.88		6.56		7.88		6.73		6.75		8.22	

TABLE IV.—*Average tensile strength of one gram sample of fiber 50 centimeters long.*

Leaf-sheath No.	Boñgulanon.		Itom.		Libuton.		Maguindanao.		Punucan.		Sinaba.	
	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.
	kg.	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*
1	81.56	111.49	104.91	103.02	79.97	99.43	93.59	113.65	106.41	103.30	87.16	107.43
2	109.62	139.44	—	128.63	84.00	93.96	95.61	117.69	119.52	100.24	102.90	104.33
3	93.98	117.93	105.89	105.57	104.99	126.16	110.54	110.62	118.51	128.81	92.24	117.81
4	93.16	148.03	—	123.07	110.18	113.34	102.44	120.88	121.61	121.21	99.09	114.51
5	110.27	114.99	112.50	122.69	182.00	93.69	105.32	120.47	116.05	124.36	104.99	114.52
6	100.69	136.96	103.68	108.00	107.08	98.65	100.50	125.97	116.47	125.25	111.97	117.26
7	99.27	130.05	121.99	121.04	89.72	126.58	105.70	129.60	94.26	127.16	127.55	127.38
8	107.94	119.23	108.65	109.00	109.44	123.00	118.37	126.75	111.47	126.96	115.87	133.30
9	97.46	133.98	126.56	151.05	88.07	117.10	111.51	133.78	128.56	144.98	133.05	154.40
10	108.31	129.02	123.89	144.13	101.40	122.54	115.31	129.98	127.77	132.39	124.10	144.62
11	105.03	119.34	117.25	140.78	89.09	109.45	94.41	131.52	111.90	128.71	108.30	149.83
12	115.81	109.65	131.94	108.62	104.19	144.04	85.29	142.37	117.91	127.35	115.22	141.37
13	102.33	100.89	99.77	140.41	113.05	125.36	96.46	99.88	140.05	125.71	134.75	142.40
14	92.71	106.57	112.41	120.08	117.80	168.23	108.86	136.70	141.88	152.07	109.16	116.64
15	94.59	115.17	127.67	103.62	123.11	145.64	101.59	124.77	134.11	137.59	—	—
16	86.09	118.49	89.67	109.30	95.39	101.23	107.64	116.84	81.16	105.88	—	—
17	86.34	94.26	58.52	104.21	107.67	146.93	103.20	148.30	79.51	77.26	—	—
18	98.24	60.41	68.06	118.19	98.17	156.23	85.62	115.90	—	—	—	—
19	84.67	86.23	—	—	131.17	133.71	87.21	89.89	—	—	—	—
20	74.72	100.07	—	—	—	—	89.90	107.87	—	—	—	—
21	76.55	91.96	—	—	—	—	—	—	—	—	—	—
Average. . .	96.16	113.53	107.08	122.59	101.92	123.43	100.95	122.17	115.71	122.90	111.88	127.55
Av. of av. .	104.84		114.83		112.67		111.56		119.30		119.71	

TABLE V.—*Average breaking stretch of fibers from the middle and edges of the different leaf-sheaths from a stalk of six varieties of abaca.*

Leaf-sheath No.	Boñgulanon.		Itom.		Libuton		Maguindanao.		Punucan.		Sinaba.	
	Middle.	Edge.	Middle	Edge.	Middle.	Edge	Middle	Edge.	Middle.	Edge.	Middle.	Edge.
	mm.	*mm.*	*mm.*	*mm.*	*mm*	*mm.*	*mm*	*mm.*	*mm*	*mm*	*mm.*	*mm.*
1	12.4	11.8	9.4	11.3	11.0	11.4	9.8	10.5	7.8	8.4	12.2	10.0
2	12.2	12.8	—	12.2	12.2	11.0	9.8	10.8	8.2	7.6	9.6	11.0
3	11.6	11.8	11.4	11.2	12.8	12.0	9.2	11.0	9.2	9.6	11.8	11.2
4	12.2	12.8	—	11.6	12.8	13.0	11.0	10.0	8.4	9.8	12.2	10.6
5	12.4	12.6	11.4	12.4	12.2	11.4	11.0	11.0	11.4	11.0	12.4	12.0
6	12.6	12.1	12.8	11.0	10.2	11.2	11.2	12.0	11.8	11.4	10.6	10.8
7	12.2	12.2	12.6	12.2	12.3	11.6	11.0	11.4	12.4	11.8	12.4	13.4
8	11.8	13.2	12.0	10.2	12.6	12.0	12.6	12.0	12.0	11.4	12.8	11.2
9	13.8	13.4	12.2	12.2	11.6	11.4	12.8	12.0	12.4	12.0	12.6	12.8
10	13.5	13.8	11.2	13.2	12.8	12.0	11.8	12.0	12.4	11.6	13.2	12.6
11	12.8	12.8	12.8	11.6	12.8	11.4	12.8	11.0	12.8	12.4	12.4	12.2
12	13.0	13.6	12.0	11.8	12.6	13.4	12.4	11.8	12.4	11.8	11.0	11.2
13	12.6	12.6	12.6	11.8	12.6	12.4	12.4	10.8	12.0	11.6	9.5	10.8
14	12.6	13.6	11.4	11.0	11.0	13.0	11.4	12.6	12.0	10.8	10.2	10.0
15	13.0	13.4	11.4	9.6	11.2	12.2	12.2	11.8	9.2	9.4	—	—
16	13.8	12.8	9.2	9.8	11.4	11.6	11.6	10.8	8.0	8.8	—	—
17	12.4	12.4	9.6	9.2	11.2	12.4	12.0	12.2	8.4	8.0	—	—
18	12.6	12.6	10.0	10.0	10.8	11.6	12.0	12.2	8.4	8.0	—	—
19	12.4	11.6	—	—	11.4	12.4	9.6	9.2	—	—	—	—
20	10.4	10.8	—	—	—	—	8.8	9.6	—	—	—	—
21	8.8	9.0	—	—	—	—	—	—	—	—	—	—
Average ..	12.3	12.4	11.4	11.2	12.9	11.9	10.7	10.6	10.[illegible]	10.4	11.6	11.3
Av. of av.	12.35		11.3		11.9		10.65		10.5		11.45	

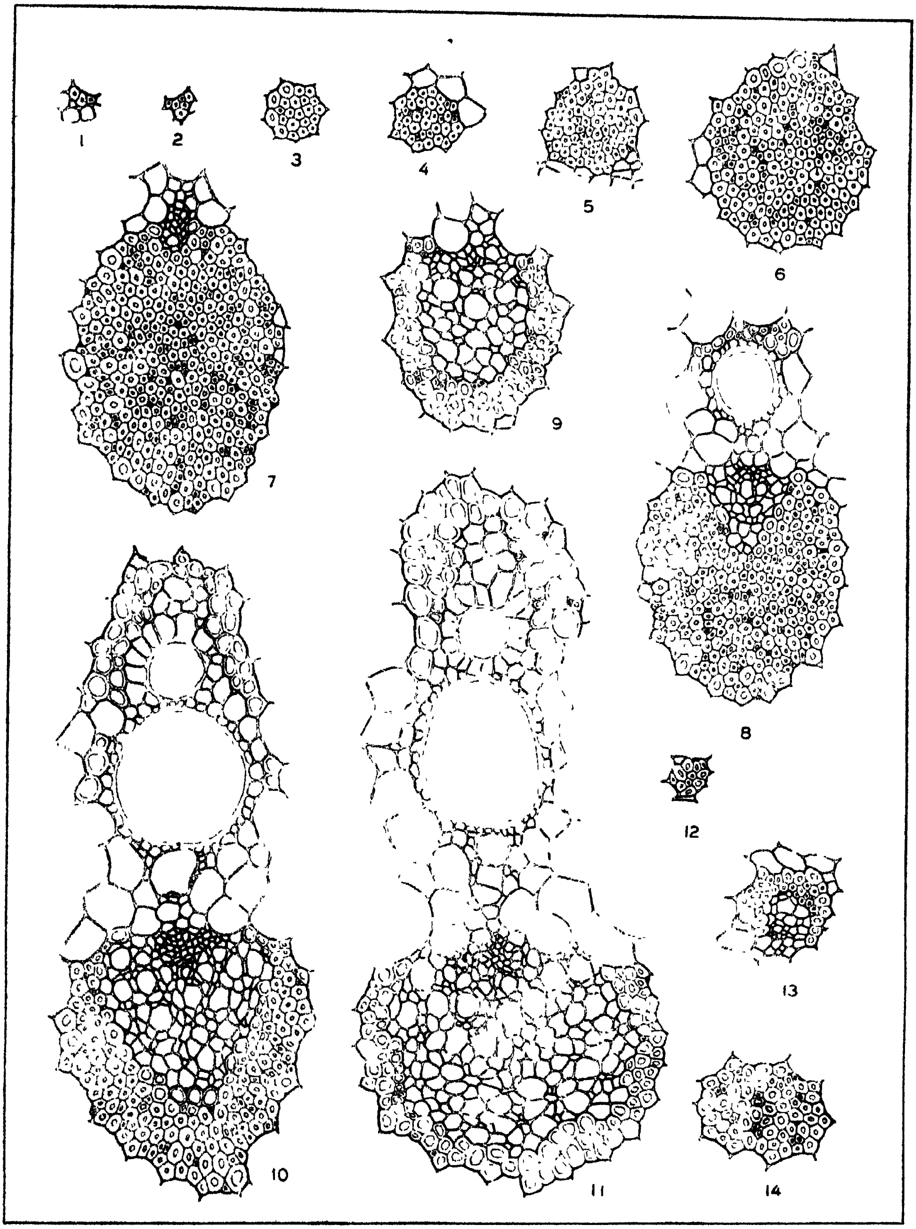
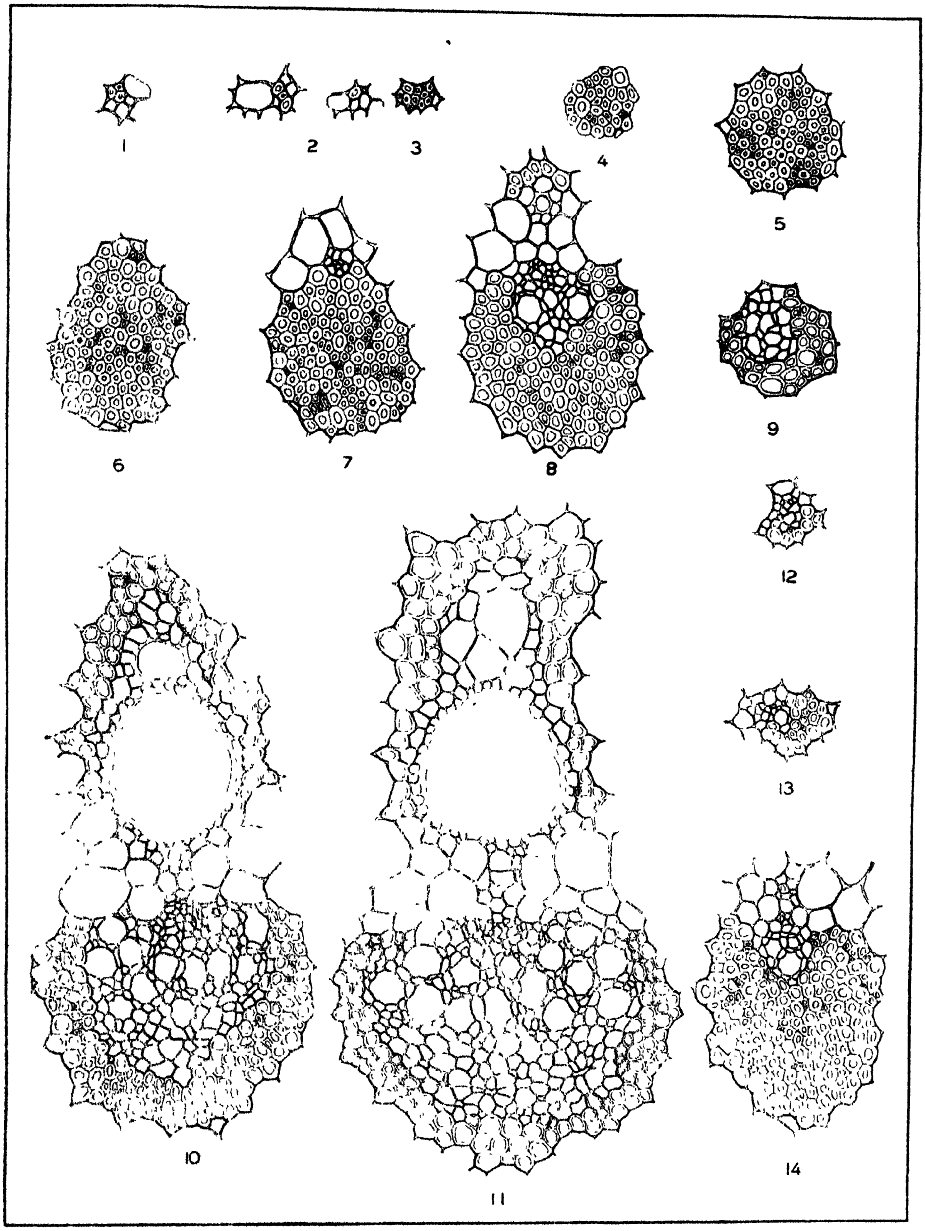


PLATE I



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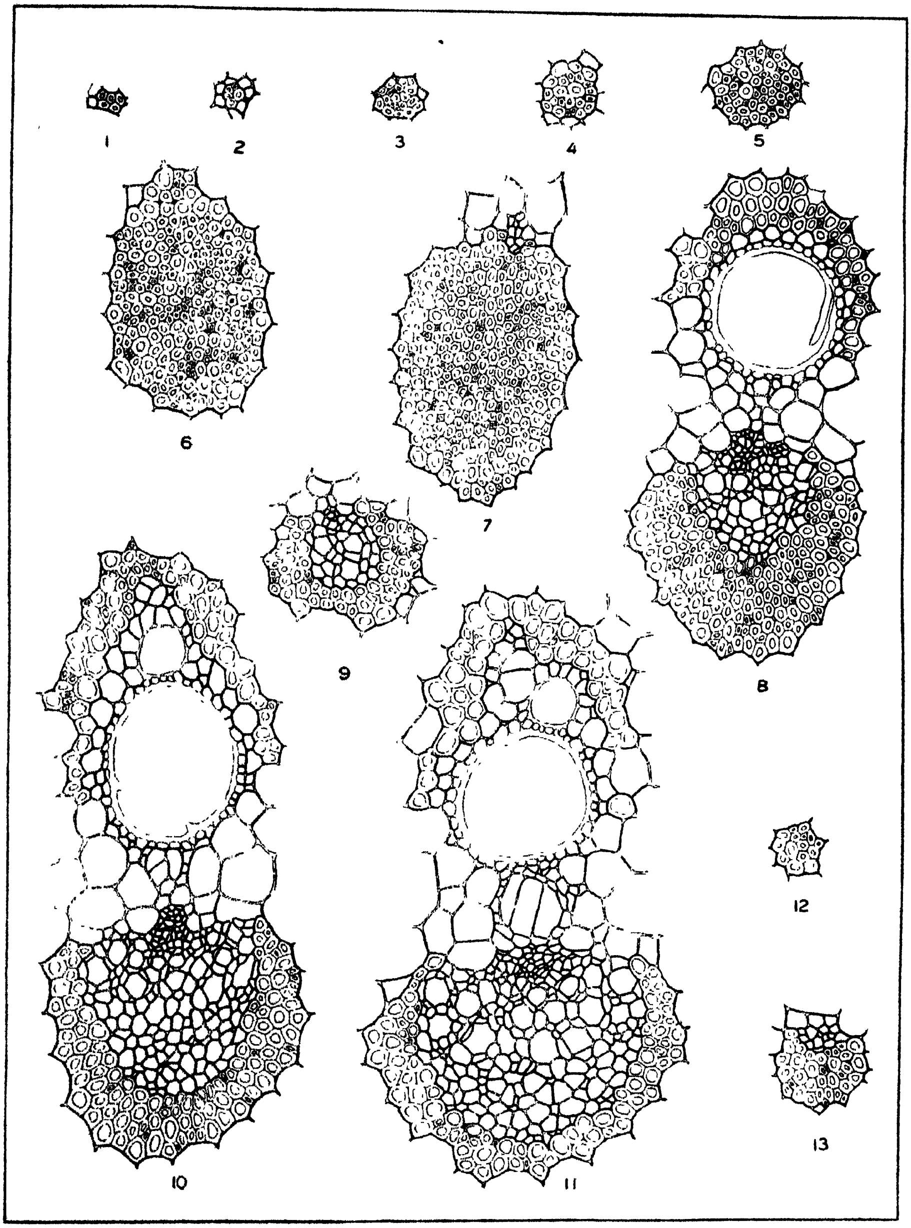

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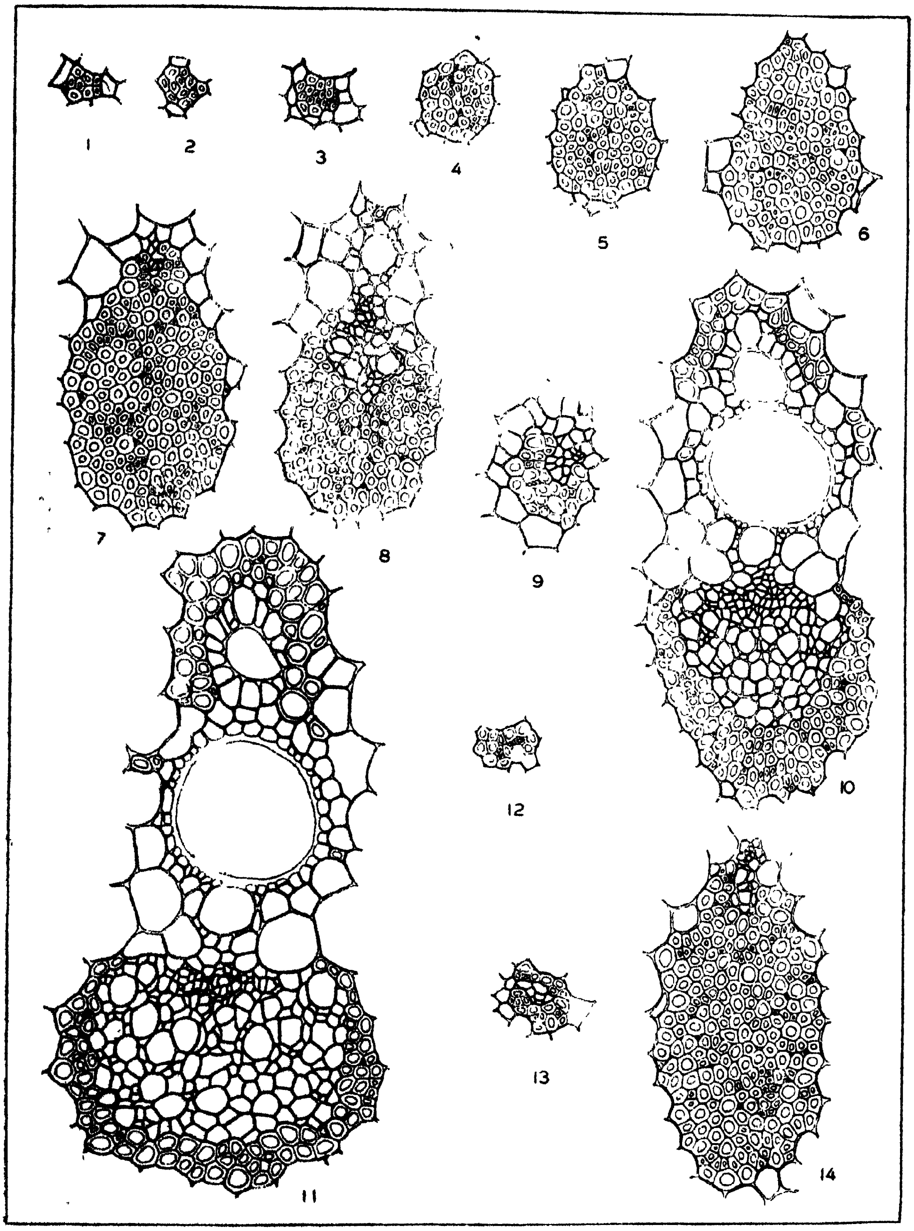

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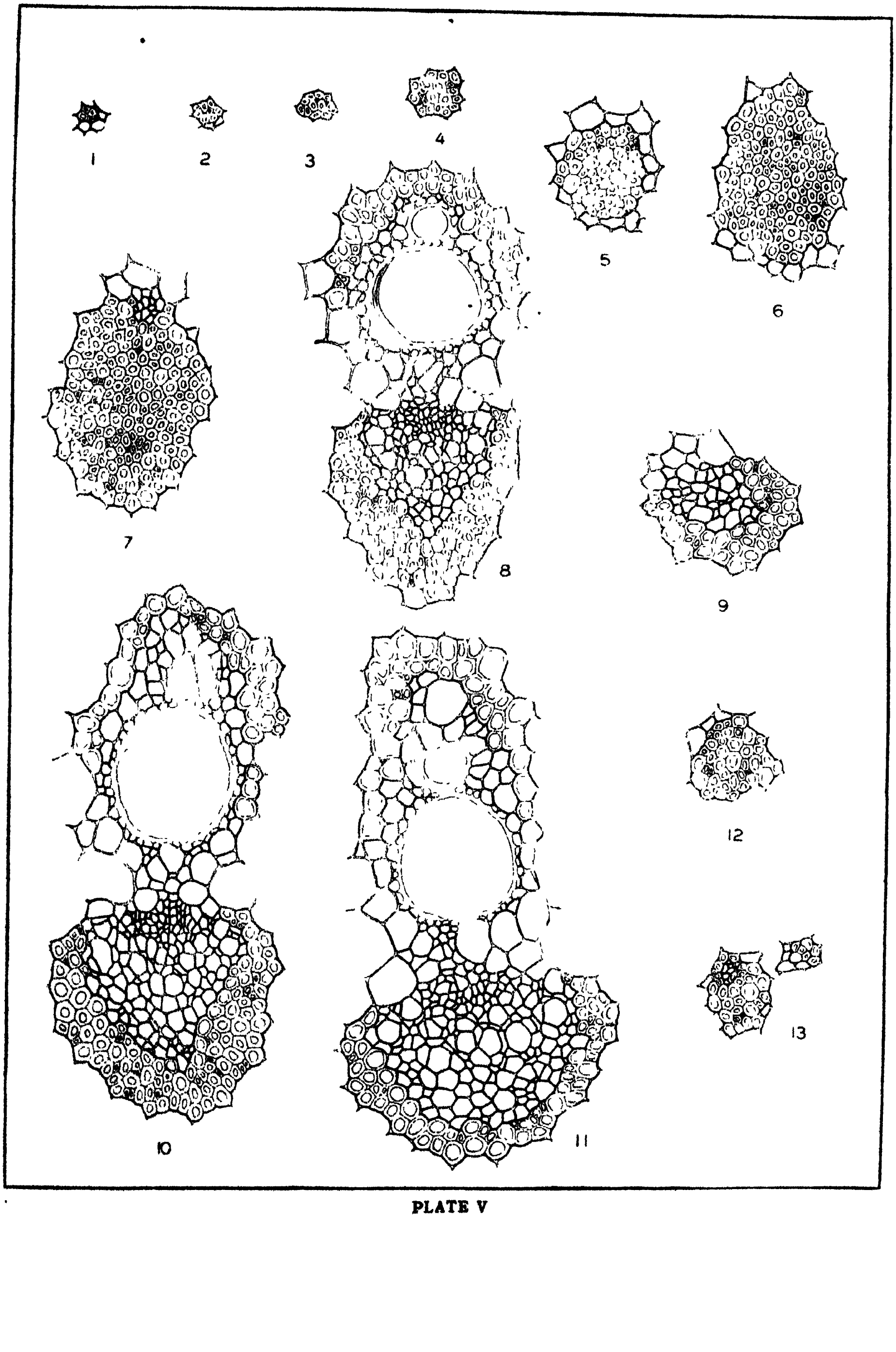

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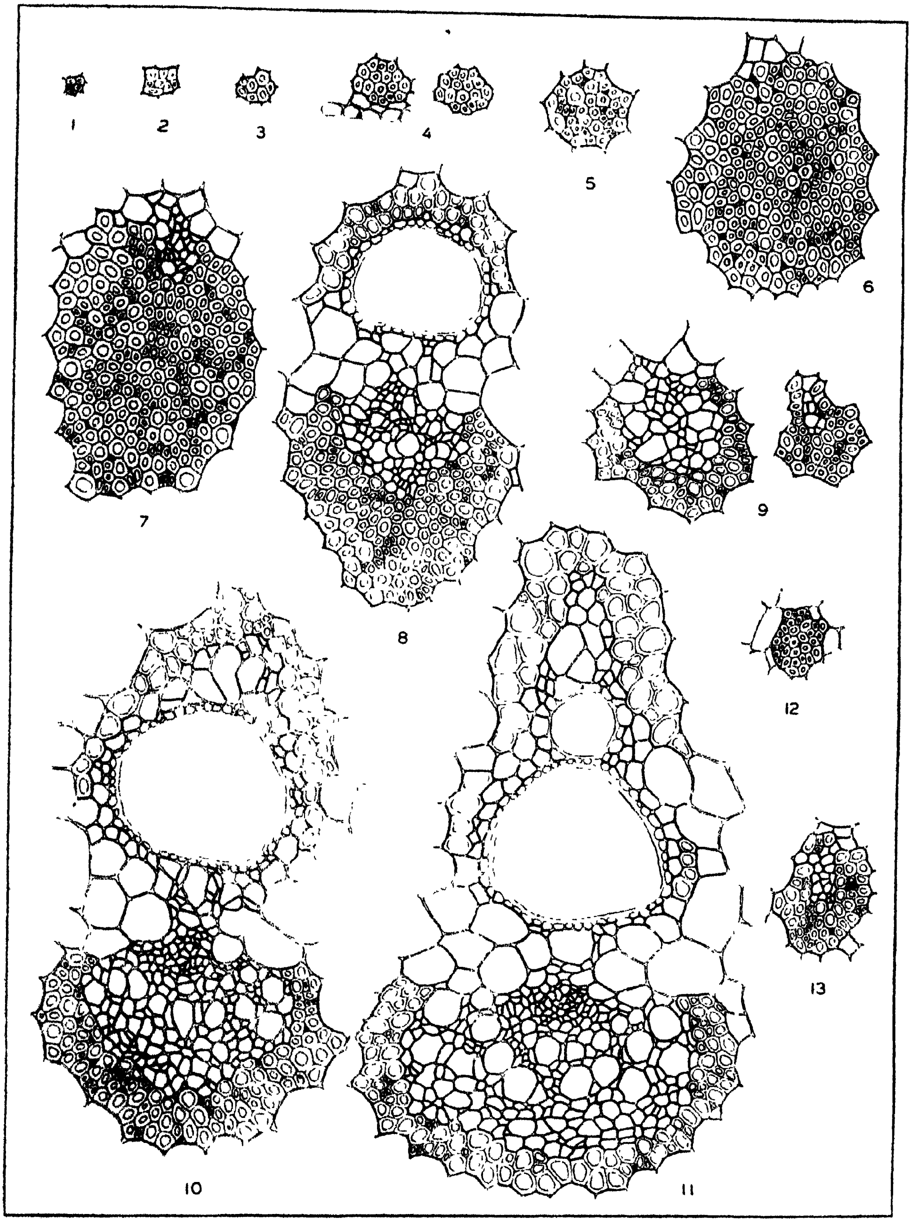

PLATE VI

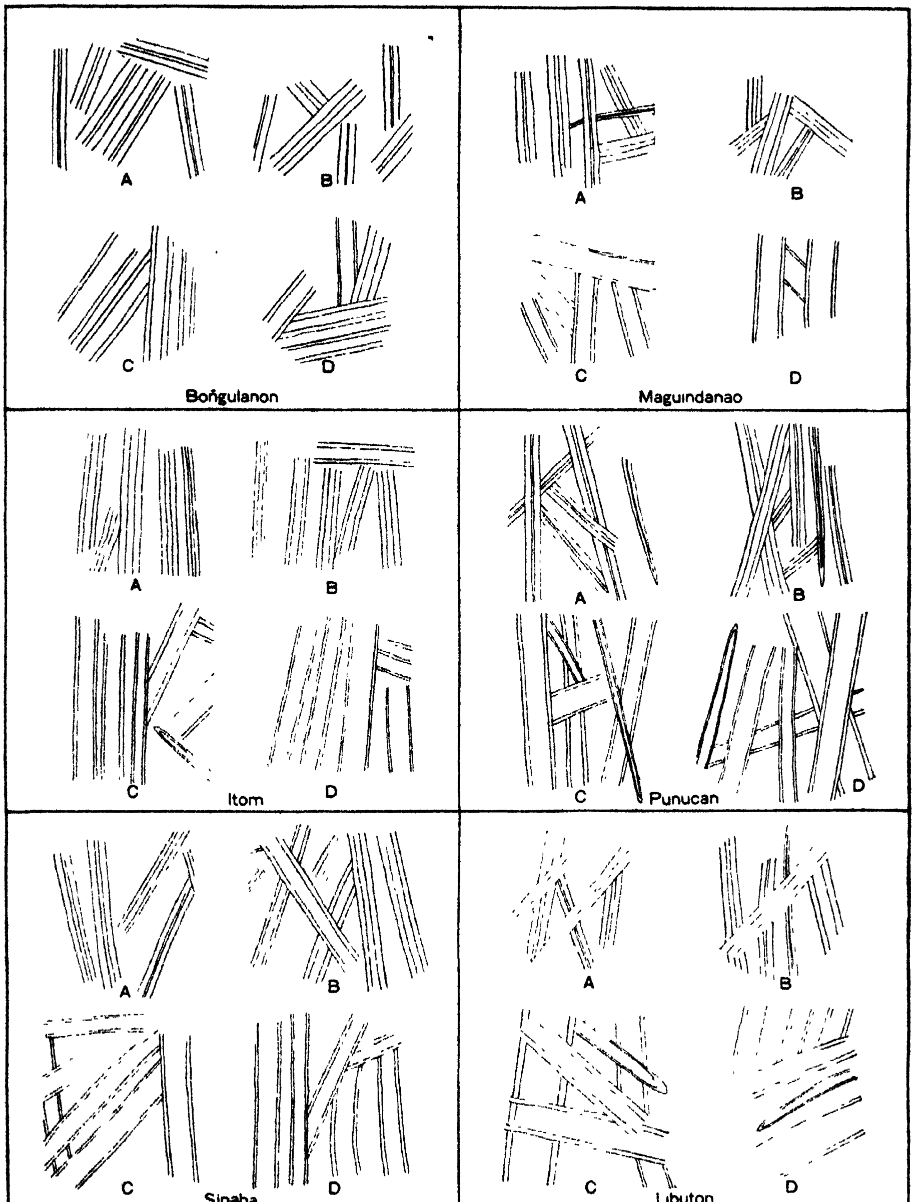
A
B
C
D
Boñgulanon
A
B
C
D
Maguindanao
A
B
C
D
Itom
A
B
C
D
Punucan
A
B
C
D
Sinaba
A
B
C
D
Libuton

PLATE VII

COMPARATIVE STUDY OF FIBERS PRODUCED BY SIX VARIETIES OF ABACA WHEN GROWN IN LOS BAÑOS: II.[1]

By R. B. Espino and José Chico Reyes

WITH SEVEN PLATES

This paper deals with the character and qualities of the fibers obtained from six varieties of abaca and is a continuation of a similar investigation started by Espino and Esguerra (1) in 1922, thereby completing the work on twelve varieties. This study was made during the college year 1922-23, and was carried out at the College of Agriculture, Los Baños.

MATERIALS, METHODS AND RESULTS

VARIETIES USED

The varieties used in this study were Pinoonan, Samoro puti, Agogaron, Ilayas, Bulao, and Kalado. These varieties are grown side by side at the College of Agriculture and so are under the same soil and climatic conditions. The first two varieties were described by Vista as follows:

a. Musa textilis Née. Var. Kalado (C. A. 4292).—Produces 6-15 sprouts to a hil but 2-5 are medium, and 3-8 small, crowded in the hill; very fast growers and erect. False stem is 2.30-2.65 meters high, 15-17 centimeters diameter at enlarged base and 9-12 centimeters diameter at top.

This variety was collected from Leyte and introduced into the College from the Bureau of Agriculture in December, 1915. The fibers are short and weak.

b. Musa textilis Née. Var. Pinoonan (C. A. 9281).—Produces about 9-10 sprouts to a hill but 2-5 are small, crowded in the hill, fast grower, slanting and poor stooler. False stem is 3.81 meters average height, 12-21 centimeters diameter at enlarged base and 7-11 centimeters diameter at top. Outer leaf-sheath green-blotched with modder brown in regular order.

This variety was collected from Barauen, Leyte, on June 6, 1919, by Mr. Lipayan.

The other four varieties as seen in the nursery may be described as follows:

c Musa textilis Née. Var. Ilayas (C. A. 10287)

Produces about 6-17 sprouts to a hill but 2-6 are small, crowded in the hill, fast grower, poor stooler. False stem is about 3.85 meters high, 22-25 centimeters diameter at enlarged base and 10-13 centimeters diameter at top.

This variety was introduced into the College from the Bureau of Agriculture on October 9, 1918.

d. Musa textilis Née. Var. Samoro puti (C. A 4279).

Produces about 8-26 sprouts to a hill but the stalks are small and slender, crowded in the hill. False stem is 2-2.74 meters high, 12-14 centimeters diameter at enlarged base and 6-7 centimeters diameter at top.

This variety was introduced into the College from Lamao Experiment Station on September 7, 1918.

e. Musa textilis Née. Var. Bulao (C. A. 169).

Produces about 4-15 sprouts to a hill, not crowded, uniform but low. False stem about 2.92 meters high and about 21 centimeters diameter at enlarged base and about 12.5 centimeters diameter at top.

This variety was introduced into the College from the Bureau of Agriculture on October 9, 1918.

f. Musa textilis Née. Var. Agogaron (C. A. 9533).

[1] Thesis presented for graduation from the College of Agriculture, No 157, Experiment Station contribution No 129.

Produces about 17 sprouts to a hill, five of which are big and twelve are small, not crowded, slanting, uniform. False stem is 2.5-2.8 meters high, 18-19 centimeters diameter at enlarged base and 9-10 centimeters diameter at top.

This variety was introduced into the College from Oas, Albay, on November 19, 1918.

MICROSCOPIC STUDY

From the outermost leaf-sheath of each of the varieties studied, microtome sections were prepared. These were taken from the middle and from portions two centimeters away from either edge, and one-half meter above the ground. The different types of fiber found in each specimen were drawn under a compound microscope with the aid of a camera lucida. The drawings are shown in Plates I-VI.

To separate the fiber cells, samples of fibers from the edges and from the middle of the outermost leaf-sheath of each variety were macerated, and representative cells drawn (see Plate VII). The dimensions of these cells were taken and the data obtained are shown (in average) in Table I.

CROSS-SECTIONAL AREA

The cross-sectional area of each of the fiber strands drawn in Plates I to VI and obtained from the different varieties studied was determined with the use of a planimeter. The data are given in Table II. In this table may be seen averages of measurements made by Espino and Esguerra (1) with the fibers of six varieties of abaca.

TENSILE STRENGTH OF FIBERS

The fibers from the edges and middle of each leaf-sheath were extracted separately. The fibers obtained were dried in the air and samples composed of five fibers of average size, 50 centimeters in length were prepared. The strength of these samples was determined with the use of the apparatus employed by Espino and Esguerra.

The relative values of the actual breaking weights (or tensile strength) are given in Table III. Table IV shows the relative values of the calculated tensile strength of fiber in terms of a gram weight of the sample.

BREAKING STRETCH

The relative stretching power of the different samples of fiber studied was measured at the time when each sample employed in the tensile strength tests broke. The average measurements are given in Table V.

DISCUSSION OF RESULTS

THE FIBER-CELLS

The length.—The data on dimensions of fiber-cells are summarized in Table I. Examination of this table will show that the fiber-cells from the edges of each leaf-sheath were shorter than those from the *middle*. The fibers from the *edges* of the leaf-sheath of Ilayas, Boñgulanon and Itom had comparatively long fiber-cells, being about 6.5898 millimeters for Ilayas. The shortest fiber-cells were from Agogaron, 2.4433 millimeters. Punucan and Bulac also had short fiber-cells from the *edges* of a leaf-sheath. The fibers of the other varieties studied not mentioned here may be considered of medium length.

Gross diameter.—As a rule the fiber-cells from the *middle* of a leaf-sheath were wider than those from the *edges*. The widest cells were from Kalado,

0.02231 millimeter. The other varieties that had wide cells were Samoro-puti, Pinoonan and Boñgulanon. The narrowest were from Agogaron, 0.01373 millimeter, closely followed by Sinaba and Punucan.

Thickness of walls.—As shown in Table I the walls of the fiber-cells from the *edges* were thicker than those from the *middle*. However, this was not true in the case of Agogaron, in which the walls of the fiber-cells obtained from the *middle* portion were thicker than those from the *edges* of the same leaf-sheath. As illustrated in Figure 1, Boñgulanon had the thickest walls. The other varieties that had relatively thick walls were Kalado, Maguindanao, Pinoonan and Libuton. The thinnest walls was exhibited by Bulao. Samoro-puti and Agogaron had also relatively thin walls. The rest of the varieties had walls which may be considered of relatively medium thickness.

Diameter of lumen.—In all cases the lumina of the fiber-cells from the *midrib* were wider than those from the *edges*. The averages for the fibers from the *edges* show that the Kalado, Samoro-puti, Pinoonan and Boñgulanon had relatively wide lumina. Agogaron, Sinaba and Punucan had narrow lumina.

THE FIBER STRANDS

Cross-sectional area.—The measurements of the cross sectional areas of the different fiber strands showed a variation ranging from 0.00036 to 0.06148 square millimeter. The first six strands as shown in Table II are purely sclerenchymatous cells. Fiber No. 7 has very little conducting tissues and as reported by Espino (2) are the largest solid fibers obtained in stripping.

The largest cross-sectional area was from the fiber of the variety Agogaron, but Espino and Esguerra found two other varieties (Boñgulanon and Sinaba) which yielded fibers still coarser than Agogaron. Of the twelve varieties so far studied and in the order of size from the coarsest to the finest (total for the 13 strands) of usually extractable fiber strands as shown in Plates I to VI, Boñgulanon was the coarsest, followed by Sinaba, Agogaron, Libuton, Ilayas, Kalado, Samoro-puti, Maguindanao, Panucan, Itom, Pinoonan, and Bulae. Of these varieties that had coarse fibers were the Boñgulanon, Sinaba and Agoraron. Relatively fine fibers were obtained from Bulao, Pinoonan and Itom (fig. 1).

Appearance in cross-section.— It will be seen in Plates I to VI that figures under F and H are purely sclerenchymatous strands. These fibers together with those shown in figures under E and I make up the bulk of the fibers found in the market. The fiber strands from the "bridge" and in the inner portions of a leaf-sheath are usually not included in the "tuxies". They are thrown away with the "waste" in stripping. Each of these vascular bundles has but one or two layers of sclerenchymatous cells. The main bulk of the constituent cells are vessels and other conducting elements.

Tensile strength.—The actual as well as the calculated tensile strength (see Tables III and IV, respectively) were greatest with fibers obtained from the leaf-sheaths somewhere between the outermost and innermost sheaths of a trunk. A similar result obtained by Espino and Esguerra from six varieties of abaca and also by Espino who advanced an explanation that the comparative weakness of the fiber from the outer leaf-sheath is due to the presence of strings of silica, or stigmata, which in turn is responsible for the brittleness of the fiber. Espino

believed that the comparatively low tensile strength of the fiber from a group of innermost leaf-sheaths is probably due to immature stage of the fiber; the walls are not yet fully developed.

The tensile strength of the fibers from the *edge* of leaf-sheaths of twelve varieties so far studied show that in terms of the breaking weight of the samples of 5 fibers each, 50 centimeters long, the fiber of Boñgulanon was the strongest; followed in strength by Sinaba, Libuton, Maguindanao, Punucan and Itom.

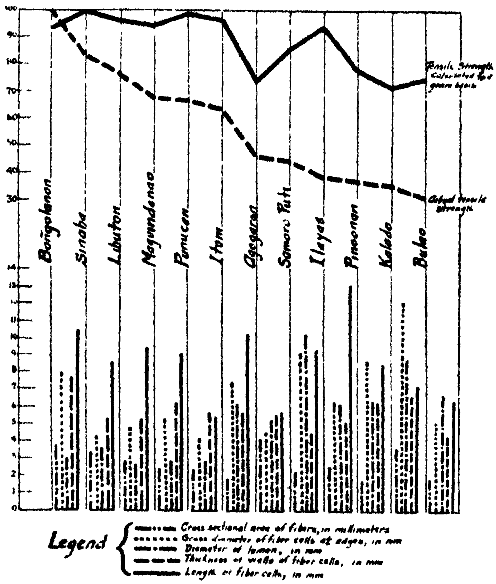

Fig. 1. Comparative tensile strength (average) of the fibers from the edges of the leaf-sheaths of 12 varieties of abaca including dimensions of cells.

(See Tables II and III and Fig. 1.) Under this criterion the weakest was Bulao. Kalado, Pinoona and Ilayas may also be considered as weak. But in terms of a given weight of the samples (see fig 1), the strongest was Sinaba, followed in a descending order by Punucan, Itom and Libuton. Relatively weak fibers were produced by Kalado, Agogaron, Bulao and Pinoonan. The other varieties not mentioned produced fibers which may be considered of medium or relatively moderate tensile strength.

As shown in Figure 1 an attempt was made to correlate the strength of the fibers of the different varieties with their respective physical characteristics. It appears that although in some varieties a large cross-sectional area of the fiber was accompanied by a high strength, yet the data on hand make it impossible to advance such a generalization for the twelve varieties so far studied. An increase in the thickness of the walls was not always accompanied by a proportionally increase in the tensile strength of the fiber. Kalado and Pinoonan, although both have relatively thick walls, the strength of the fibers were relatively low. It is suggested that irrespective of the thickness cell-walls, the area of the fiber, or of any of the known qualities of the fiber and of the fiber-element, the fibers of the different varieties may naturally and peculiarly be strong or weak.

Breaking stretch.—The data on the *breaking stretch* of the fibers from the varieties just studied together with those studied by Espino and Esguerra showed that in almost all cases the fibers from the *midrib* had a greater breaking stretch than the corresponding fiber from the *edges* of each leaf-sheath of the same variety. The difference, however, was very small. In the majority of cases the breaking stretch was proportional to the load that was sustained by the fiber. In other words the tensile strength was usually accompanied by a corresponding high stretching power of the fiber.

SUMMARY AND CONCLUSIONS

1. The fiber-cells from the edges of the leaf-sheath of Ilayas, Boñgulanon, and Itom were comparatively long while Agogaron had the shortest. Punucan and Bulao had also short fiber-cells and the rest were of medium length.

2. Kalado had the widest fiber-cells, this being 0.0223 millimeter. Samoro-puti, Pinoonan and Boñgulanon had also wide cells. The narrowest (0.01373 mm.) were from Agogaron. Sinaba and Punucan may also be considered to have narrow fiber-cells.

3. Boñgulanon had the thickest cell wall followed in thickness by Kalado, Maguindanao, Pinoonan and Libuton. Bulao had the thinnest. Samoro-puti and Agogaron had also thin walls. The rest had walls of medium thickness.

4. Kalado. Samoro-puti, Pinoonan and Boñgulanon had relatively wide lumina. The lumina of the fiber elements of Agogaron, Sinaba and Punucan were narrow.

5. The varieties Boñgulanon, Sinaba and Agogaron produced coarse fibers; while the fibers obtained from Bulao, Itom and Pinoonan were relatively fine.

6. Comparatively short fibers were obtained from the leaf-sheaths somewhere between the outermost and innermost leaf-sheaths in a trunk of abaca. In terms of the number of filaments Bongulanon had the strongest fibers followed in strength, in a descending order by Sinaba, Libuton, Maguindanao, Punucan and Itom. The weakest fibers were from Bulao. Kalado, Pinoonan, and Ilayas also had relatively weak fibers. But in terms of a given weight of the sample the strongest was Sinaba. Punucan, Itom and Libuton also had strong fibers. Agogaron, Bulao and Pinoonan produced relatively weak fibers. The others may be considered of medium strength.

7. Although in some way coarseness of the fibers and thickness of the cell-walls are largely responsible for the strength of the fibers, yet the data on hand seem to show that fibers of certain varieties are naturally either strong or weak, irrespective of these qualities.

8. A high tensile strength was usually accompanied by a corresponding high stretching power of the fibers.

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ILLUSTRATIONS

Plate I

ABACA VAR. PINOONAN

From the midrib:

A. Figure 4—Fiber strand with purely sclerenchymatous cells, near inner epidermis.
B. Figures 1-3 small vascular bundles, near inner epidermis.
C. Figures 5 and 6 big vascular bundles at the "bridge".
D. Figures 12 and 16 big vascular bundles near the "bridge".
E. Figures 7 and 8 fiber strands with little conducting tissues near outer epidermis.
F. Figures 9-11 and 13-15 fiber strands with purely sclerenchymatous cells, near outer epidermis.

From the edge:

G. Figures 17-22 fiber strands with purely sclerenchymatous cells.
H. Figures 23 and 24 fiber strands with little conducting tissues.
I. Figure 25 big vascular bundle.

Plate II

ABACA VAR. SAMORO PUTI

From the midrib:

A. Figure —Fiber strand with purely sclerenchymatous cells, near inner epidermis.
B. Figures 1-4 small vascular bundles near inner epidermis.
C. Figures 5 and 6 big vascular bundles at the "bridge"
D. Figures 13 and 15 big vascular bundles near the "bridge".
E. Figure 8 fiber strand with little conducting tissue, near outer epidermis
F. Figures 7, 9-14 fiber strands with purely sclerenchymatous cells, near outer epidermis.

From the edge:

G. Figures 16, 19, 21 and 22 fiber strands with purely sclerenchymatous cells
H. Figures 20, 23 and 24 fiber strands with little conducting tissues
I. Figure 25 big vascular bundle.

Plate III

ABACA VAR AGOGARON

From the midrib:

A. Figures 2 and 3 fiber strands with purely sclerenchymatous cells, near inner epidermis.
B. Figures 1 and 4 small vascular bundles near inner epidermis
C. Figures 5 and 6 big vascular bundles at the "bridge".
D. Figures 13 and 16 big vascular bundles near the "bridge".
E. Figures 7 and 8 fiber strands with little conducting tissues, near outer epidermis.
F. Figures 9-15 fiber strands with purely sclerenchymatous cells, near outer epidermis.
G. Figures 18, 20-22 and 24 fiber strands with purely sclerenchymatous cells.
H. Figures 17, 19, 23 and 25 fiber strands with little conducting tissues.
I. Figure 26 big vascular bundle.

Plate IV

ABACA VAR. ILAYAS

A. Figure 23 fiber strand with purely sclerenchymatous cells, near inner epidermis.
B. Figures 20 and 21 small vascular bundles, near inner epidermis.
C. Figure 22 big vascular bundle at the "bridge".
D. Figures 16, 19 and 24 big vascular bundle near the "bridge".
E. Figure 12 fiber strands with little conducting tissues, near outer epidermis.
F. Figures 11, 13-15, 17 and 18 fiber strands with purely sclerenchymatous cells, near outer epidermis.

From the edge:

G. Figures 1, 4, 5, and 7-9 fiber strands with purely sclerenchymatous cells.
H. Figures 2 and 3 fiber strands with little conducting tissues.
I. Figures 6 and 10 big vascular bundles.

PLATE V

ABACA VAR. BULAO

From the midrib:

A. Figure 3.—Fiber strand with purely sclerenchymatous cells, near inner epidermis.
B. Figures 1 and 2 small vascular bundles near inner epidermis.
C. Figure 4 big vascular bundle at the "bridge".
D. Figures 6 and 8 fiber strands with little conducting tissues, near outer epidermis.
E. Figures 7, 9-12 and 14 fiber strand with purely sclerenchymatous cells, near outer epidermis

From the edge:

F. Figures 16-19, 21 and 22 fiber strands with little purely sclerenchymatous cells.
G. Figures 20-24 fiber strands with little conducting tissue
H. Figure 25 big vascular bundle

PLATE VI

ABACA VAR. KALADO

From the midrib:

A Figures 1 and 4 fiber strands with purely sclerenchymatous cells near inner epidermis.
B. Figures 2 and 3 small vascular bundles near inner epidermis.
C. Figure 5 big vascular bundle at the "bridge".
D Figures 6, 15 and 18 big vascular bundles near the "bridge"
E. Figures 9 and 11 fiber strands with little conducting tissues, near outer epidermis.
F. Figures 7, 8, 10, 12, 13-17 fiber strands with purely sclerenchymatous cells near the outer epidermis.

From the edge:

G Figures 19, 22, 23, 25-27 fiber strands with purely sclerenchymatous cells.
H. Figures 20 and 21 fiber strands with little conducting tissues.
I. Figures 24 and 28 big vascular bundles.

PLATE VII

FIBER CELLS OF SIX VARIETIES OF ABACA

Figures 1 and 2, fiber cells from the edge and midrib, respectively, of variety Agogaron.
Figures 3 and 4, fiber cells from the edge and midrib, respectively, of variety Ilayas
Figures 5 and 6, fiber cells from the edge and midrib, respectively, of variety Pinoonan.
Figures 7 and 8, fiber cells from the edge and midrib, respectively, of variety Bulao.
Figures 9 and 10, fiber cells from the edge and midrib, respectively, of variety Kalado.
Figures 11 and 12, fiber cells from the edge and midrib, respectively, of variety Samoro puti.

TABLE I.—*Average dimensions of fiber-cells.*

Origin of fiber-cell.	Variety name.	Dimensions of fiber-cells.			
		Gross diameter.	Diameter of lumen.	Thickness of wall.	Length.
		mm.	*mm.*	*mm.*	*mm.*
From edges of leaf-sheath	Pinoonan	.01895	.00644	.00640	4.4789
	Samoro puti	.01915	.01041	.00437	4.6409
	Agogaron	.01373	.00445	00464	2 4433
	Ilayas	.01646	.00624	.00511	6.5898
	Bulao	.01537	00679	00433	3.1179
	Kalado	02231	00889	00683	3 7024
From middle of leaf-sheath	Pinoonan	.01985	01143	.00421	6 3093
	Samoro puti	02215	.01490	00367	5.5477
	Agogaron	01880	00835	00542	3 8610
	Ilayas	02040	.01229	00410	7.5701
	Bulao	.02079	.01326	00402	4.0447
	Kalado	.02313	01431	.00441	4 3620
Edges and middle (averages)	Pinoonan	01940	.00894	00532	5.3941
	Agogaron	.01627	00640	.00503	3.1522
	Ilayas	.01843	.00927	.00461	7 0800
	Bulao	.01808	.01003	.00418	3.5813
	Kalado	.02272	.01160	.00562	4.0322

TABLE II.—*Cross-sectional area of sclerenchyma strands obtained from different parts of a sheath of each of six varieties of abaca.*

Strand No.	From edges. Pinoonan.	From edges. Samoro puti.	From edges. Agogaron.	From edges. Ilayas.	From edges. Bulao.	From edges. Kalado	From middle. Pinoonan.	From middle. Samoro puti.	From middle. Agogaron.	From middle. Ilayas.	From middle. Bulao.	From middle. Kalado.
	sq. mm.	*sq. mm.*	*sq. mm.*	*sq. mm.*	*sq. mm.*	*sq mm.*	*sq mm.*	*sq. mm.*	*sq. mm.*	*sq. mm.*	*sq. mm.*	*sq. mm.*
1	.00071	00068	.00071	00036	00048	00095	00101	00074	00068	00053	.00068	.00042
2	00083	.00125	00151	00889	00143	00149	00143	00178	00101	00662	00178	00143
3	.00318	.00291	00281	00232	00193	00193	00291	00261	.00211	00258	00303	.00309
4	.00956	.00585	00591	00478	00428	00508	.00460	00398	00309	00891	00422	00400
5	.01072	.01342	01203	01016	00787	01054	00728	00933	00787	01880	00817	.00817
6	.02082	01696	03267	02822	01408	02896	01910	02471	02747	02928	.01559	.02349
7	.03053	.03718	.04514	03858	03124	04517	04458	.04505	05192	04915	03647	.03816
8	03686	.04069	.06038	04253	03080	04814						
9	.00582	.00600	01758	01197	.01114	01143						
10	.02328	02964	.05192	04823	01669	03828						
11	03460	.04782	05842	03867	04666	06148						
12	.00244	00502	00647	00526	00395	00481						
13	.00214	00662	00846	00469	.00309	00633						
Total from 1 to 7 incl.	07635	07825	10078	08531	06131	09412	08091	08820	09415	10987	06991	07966
Total from 8 to 13 incl.	.10514	13579	20323	15135	11233	17047						
Total ..	18149	.21404	30401	23666	17364	26459						

	Bongulanon	Libuton	Maguindanao	Itom	Sinaba	Punucan
Total from 1 to 7 incl.	14458	.10554	09212	04903	12689	07534
Total from 8 to 13 incl	22093	18084	11918	14715	19980	13535
Total...	36551	28638	21130	.19618	32669	21069

TABLE III.—*Relative values of the actual breaking weights (or tensile strength).* a

Leaf-sheath No.	Data from the present study.						Data from Espino and Esguerra.					
	Pino-onan.	Sa-moro puti.	Agoga-ron.	Ilayas	Bulao.	Kala-do.	Bo-ñgula-non.	Itom.	Libu-ton.	Ma-guin-danao.	Punu-can.	Si-na-ba.
1	29	30	31	32	27	24	75	48	56	44	50	66
2	35	29	36	29	24	26	74	56	62	46	50	69
3	28	22	35	31	24	29	74	59	66	49	57	71
4	35	32	46	40	23	26	72	45	75	50	58	74
5	30	37	45	36	27	29	83	67	60	53	61	74
6	29	34	42	32	21	26	79	61	69	61	64	78
7	27	31	41	35	25	31	83	69	74	65	60	68
8	33	39	38	31	25	28	86	57	77	72	63	70
9	30	33	42	35	27	29	99	67	67	78	55	64
10	35	40	43	31	21	27	100	59	61	73	51	56
11	25	38	41	28	25	23	78	56	60	54	52	45
12	21	38	40	32	22	23	89	51	66	48	47	41
13	22	38	37	26	20	21	80	43	64	54	43	43
14	21	40	24	23	20	22	80	36	56	49	44	28
15	20	32	20	20	20	15	70	30	48	43	42	
16	14	29	21	18	20	17	67	22	32	38	28	
17		25	18	17	17		56	20	32	35	18	
18			14	11			56	19	36	31		
19				12			48		26	25		
20							54			26		
21							25					
Min.	14	22	14	11	17	15	25	19	26	25	18	28
Max...	35	40	46	40	27	31	100	69	77	78	64	78
Av. *a*.	27.1	33.4	34.1	27.3	22.8	24.8	72.8	48.1	57.2	49.7	49.6	60.5
Relative value of average	37	46	47	38	31	34	100	66	76	69	68	83

a The highest record of the *actual breaking weight* was considered as 100, the others were reduced relatively

TABLE IV.—*Relative values of the calculated tensile strength of fiber in terms of a gram weight of the sample.*

Leaf-sheath No.	Data from the present study.						Data from Espino and Esguerra (1).					
	Pino-onan.	Sa-moro puti.	Agoga-ron.	Ilayas.	Bulao.	Kala-do.	Bo-ñgula-non	Itom.	Libu-ton.	Ma-guin-danao	Punu-can.	Si-na-ba.
1	60	65	48	61	54	39	66	71	61	70	71	66
2	67	59	57	63	57	48	85	87	60	72	75	70
3	59	60	49	56	61	50	72	72	79	75	84	72
4	68	58	68	69	54	63	82	84	76	76	83	73
5	57	64	61	67	60	58	77	80	94	77	82	75
6	68	60	66	71	71	64	81	72	70	77	82	78
7	74	71	62	72	71	63	78	83	74	80	75	87
8	71	67	57	67	69	58	77	74	79	83	81	85
9	68	67	55	71	65	59	79	94	70	83	93	98
10	70	69	53	77	68	55	81	91	76	83	89	91
11	70	80	52	73	66	57	76	88	68	77	82	88
12	58	84	52	73	65	59	77	82	85	77	83	87
13	56	79	64	75	57	63	69	82	81	67	90	94
14	69	80	66	70	62	67	68	79	97	83	100	77
15	65	77	73	82	48	56	71	79	91	77	92	
16	55	76	65	81	51	72	70	68	67	76	64	
17		79	63	76	53		61	90	87	85	53	
18			71	62			54	63	87	68		
19				66			58		90	60		
20							60			67		
21							57					
Min.	55	58	48	56	48	39	54	63	60	60	53	66
Max.	74	84	73	82	71	72	85	94	97	85	100	98
Av *a*	64.7	70.3	60.1	76.1	60.7	58.2	71.4	79.9	78.5	75.7	81.1	81.5
Relative value of average	79	86	74	94	75	71	87	97	96	93	99	100

a The highest record was considered as 100, the rests were computed accordingly.

TABLE V.—*Average breaking stretch of fibers from the middle and edges of the different leaf-sheaths from a stalk of six varieties of abaca.*

Leaf-sheath No.	Pinoonan.		Samoro puti.		Agogaron.		Ilayas.		Bulao.		Kalado.	
	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.	Middle.	Edge.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1	13.4	11.4	10.4	11.6	9.4	7.6	10.6	9.6	11.4	8.4	11.2	8.4
2	18.6	13.2	13.2	10.0	12.8	9.2	10.2	9.6	12.6	10.4	10.8	9.2
3	16.4	12.2	12.0	5.2	13.0	11.8	10.2	9.2	11.0	9.2	11.0	10.6
4	20.8	15.4	11.2	9.2	13.2	11.8	12.6	11.4	11.2	8.6	10.4	13.0
5	16.4	15.0	14.6	9.4	10.6	10.2	12.0	10.8	11.4	8.8	11.2	10.4
6	18.0	11.6	12.2	11.2	14.0	8.2	10.0	9.2	10.8	9.8	9.6	10.2
7	14.0	10.6	12.4	10.2	13.2	12.0	9.6	13.0	11.8	9.4	10.2	9.6
8	14.0	9.4	13.4	11.0	12.8	12.0	9.4	10.6	8.2	7.6	10.6	9.4
9	12.0	9.2	15.4	11.0	15.4	14.0	11.4	11.2	9.8	8.2	10.2	9.0
10	14.8	10.0	14.6	11.8	17.8	13.6	12.0	11.6	9.8	9.4	11.6	9.8
11	12.2	10.2	13.2	10.8	15.2	13.2	10.4	10.2	9.6	10.4	11.0	10.4
12	10.0	11.2	15.2	10.4	12.6	15.4	12.6	10.4	10.0	9.4	10.4	10.6
13	10.8	11.0	14.4	11.2	15.0	13.8	14.4	8.8	10.0	8.6	10.4	9.8
14	12.2	10.0	17.2	12.4	10.8	10.6	11.0	8.3	10.0	9.0	9.8	9.6
15	11.4	8.6	11.2	11.0	11.0	11.2	9.4	9.8	11.2	8.2	8.0	9.4
16	7.6	7.4	12.8	11.0	11.4	10.6	9.2	8.6	9.2	9.0	9.0	10.0
17			12.0	10.2	10.2	8.8	9.4	6.8	9.4	8.6		
18					8.4	7.4	7.4	7.8				
19							7.6	7.8				
Average...	13.91	11.03	13.26	10.45	12.60	11.19	10.49	9.72	10.44	9.00	10.34	9.96
Average...	12.47		11.86		11.90		10.11		9.72		10.15	

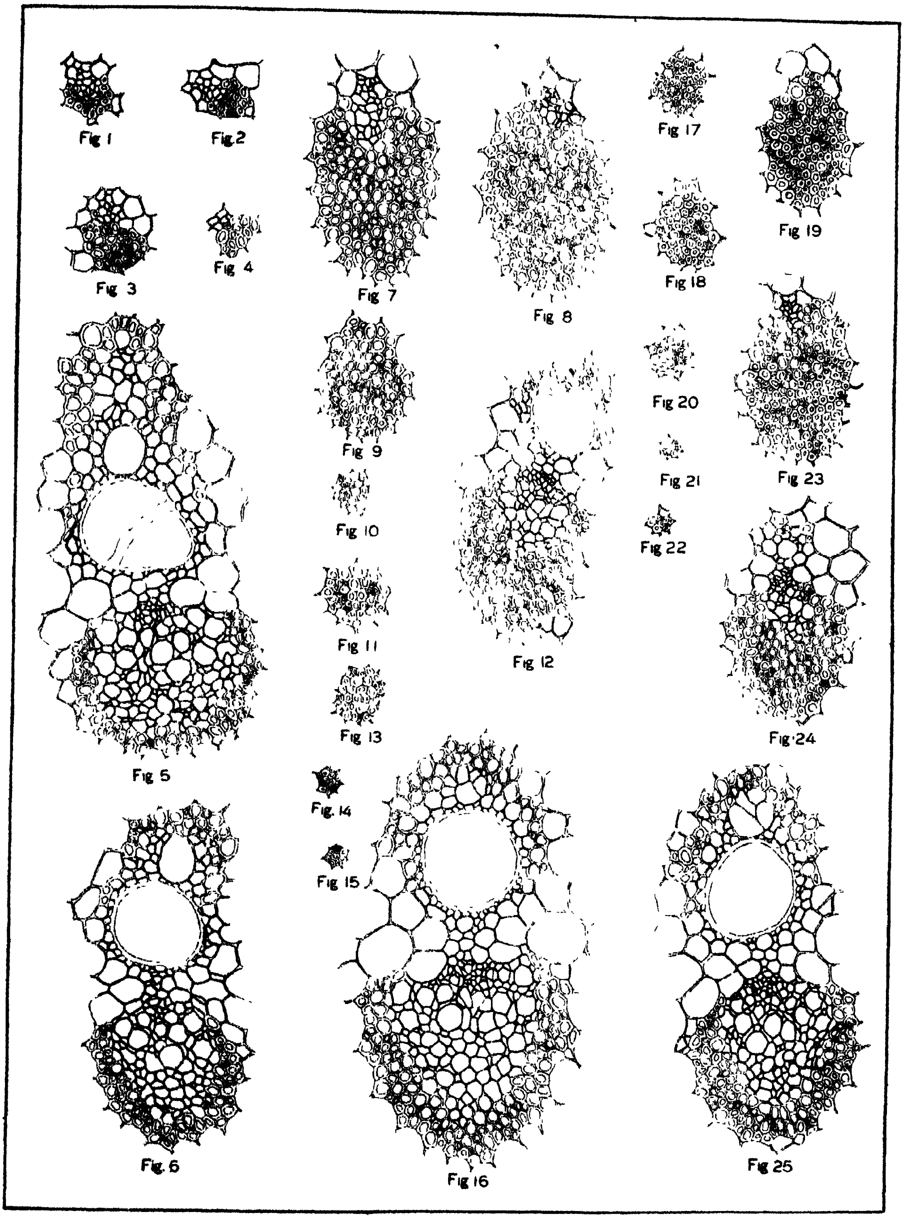
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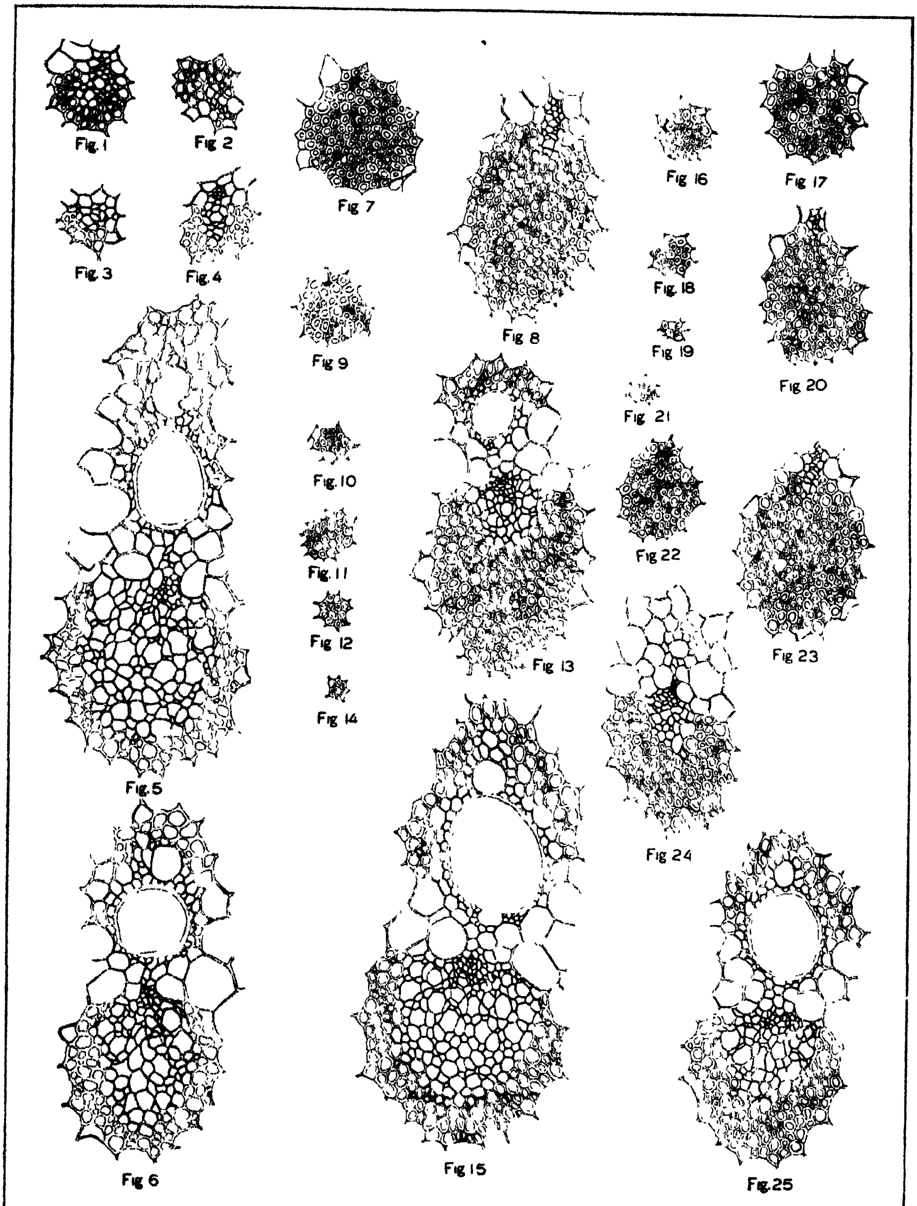
PLATE I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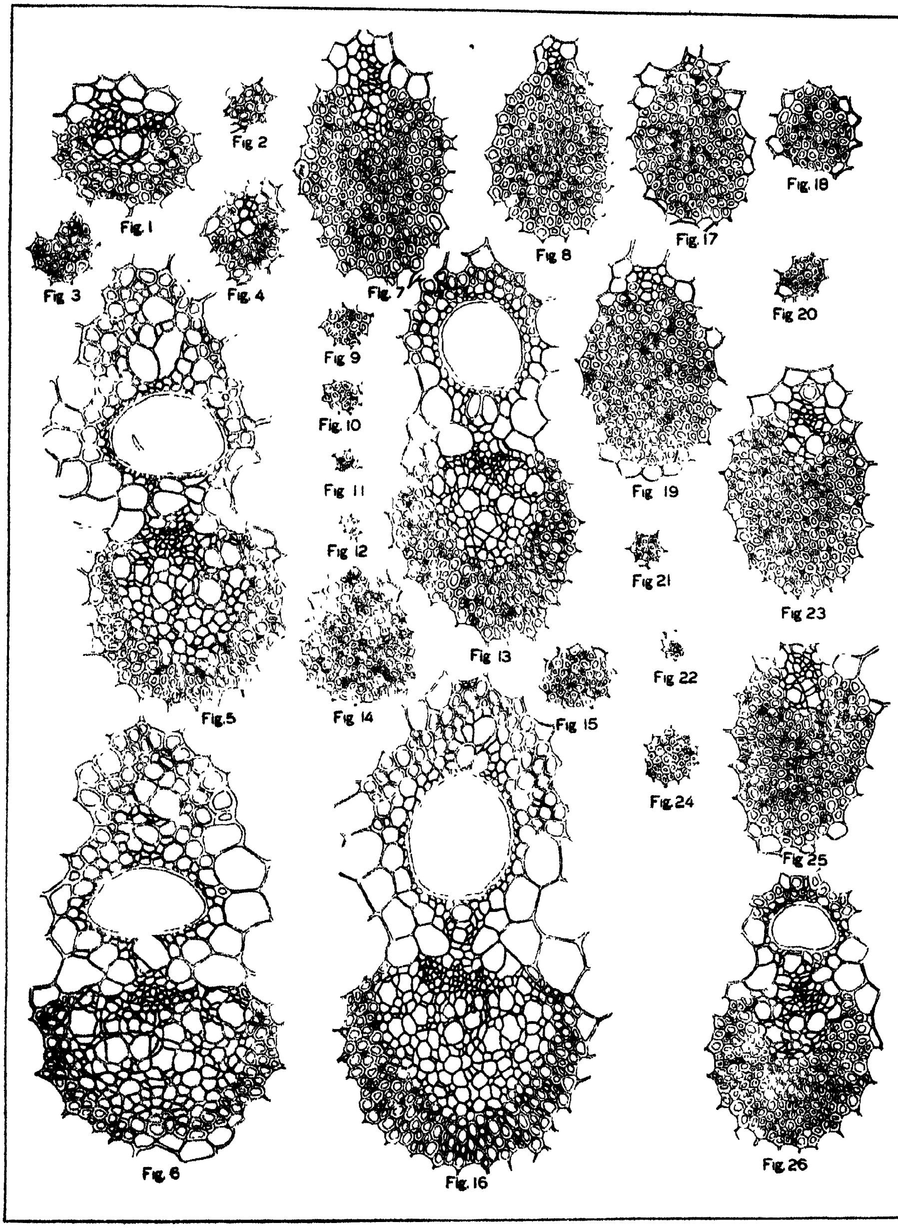
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PLATE III

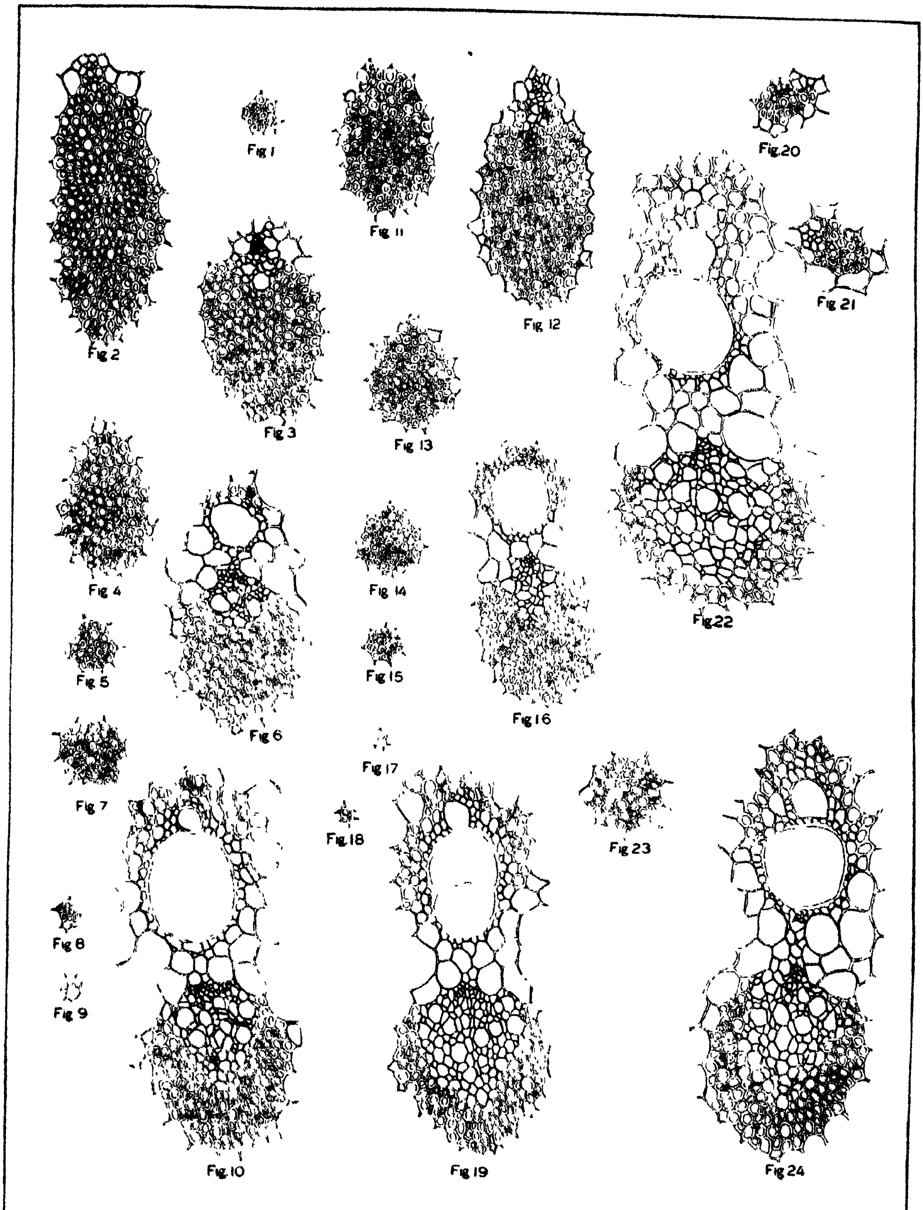
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PLATE IV

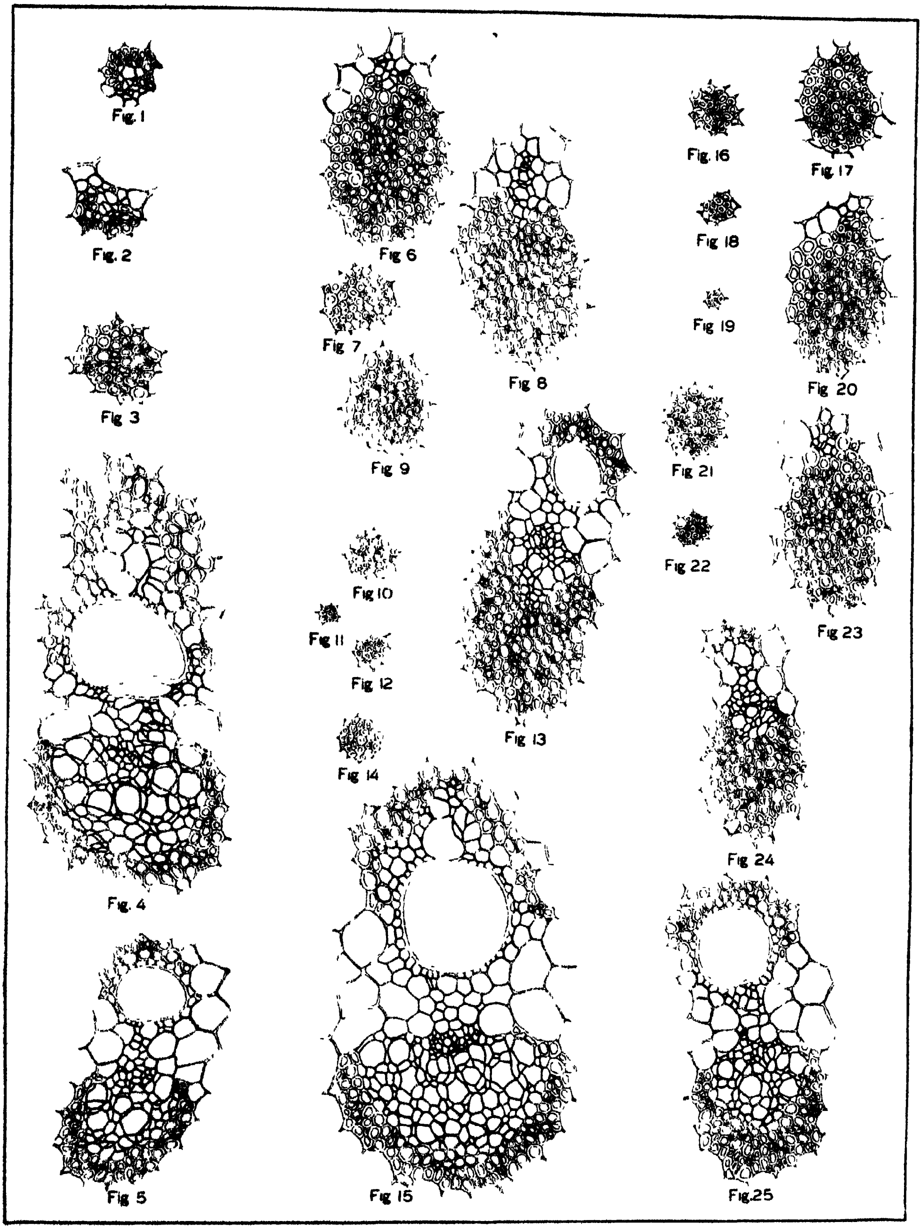
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PLATE V

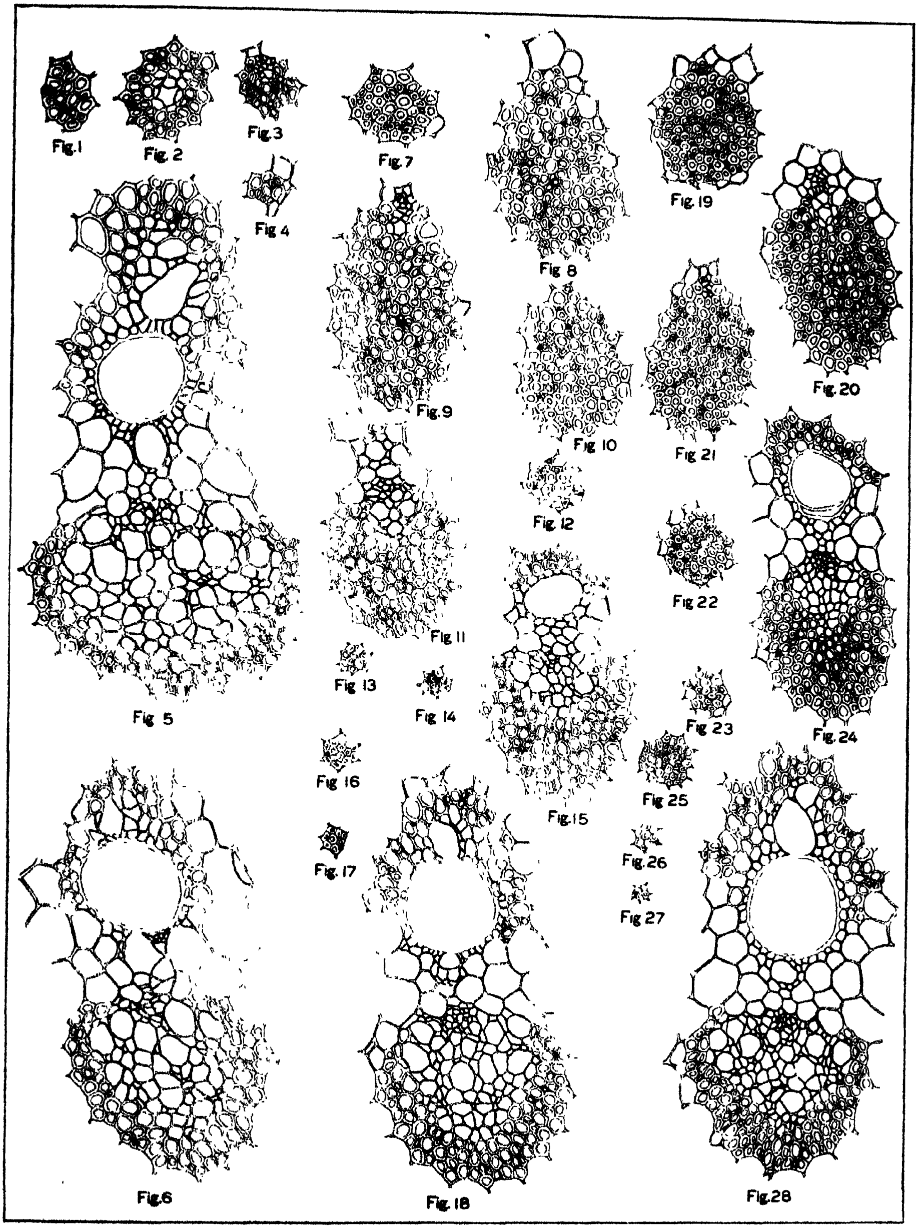
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PLATE VI

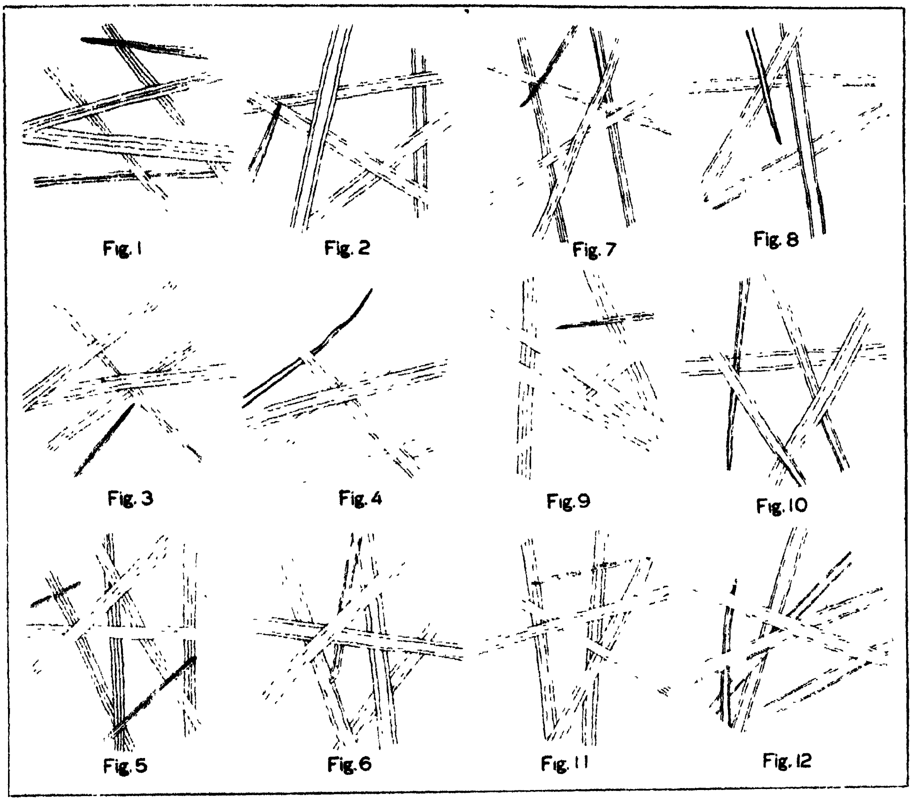
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PLATE VII

COMPARISON OF FORTY-SEVEN VARIETIES OF ABACA GROWN UNDER LOS BAÑOS CONDITIONS[1]

By R. B. ESPINO and TEOFILO NOVERO
Of the Department of Agronomy

This paper is a report of an attempt to study the root-systems of the varieties of abaca in this College that have attained full development. Incidentally, some of the gross vegetative structures were also studied. Some of the desirable as well as undesirable qualities are here reported. It is hoped that the facts here given may be of value from the cultural point of view and may contribute to our rather limited knowledge of the varieties as a whole.

MATERIALS, METHOD, AND RESULTS

The varieties of abaca here studied were gathered by the College from different parts of the Philippines. As our records show, each variety was given a College accession number and bears the name that it had in its place of origin.

The most thoroughly developed clump or hill of each of the varieties was studied. In case of individual plants only those that were flowering or fruiting were measured. In counting the plants of a clump, the small, as well as the large ones, were included.

In the study of the distribution of roots in the ground, a trench in the form of an arc one-half meter from the hill was dug vertically. The trench was about one-half meter in width and varied in length, depending upon the size of the clump of the plant. But its length was measured. The length of the remaining part of the circumference of a circle round the hill was also determined. The number of roots around each clump was calculated by dividing the number of roots in each trench by the length of the trench. The product was afterward multiplied by the sum of the lengths of the trench and of the circumference of a circle around the hill. The relative distribution in depth of the roots in each trench was determined by counting the roots in zones of five centimeters each from the surface of the ground. Owing to the large space that would be required to publish all the data, it was decided to show in this report only the results obtained from a few desirable varieties (See Table II).

Likewise, only a summary of the extensive data on hand is here included. Table I shows the comparison of the abaca varieties studied in certain vegetative structures.

DISCUSSION OF RESULTS

UNDESIRABLE QUALITIES

Examination of the data in Table I will show the following varieties possessing certain *undesirable* qualities:

a. With less than 10 stalks to the hill.—Banguisan, Baguisanon-Lawaan, Laguis (C. A.) 4285), Lagurhuan Dogami, Layahon, Libutanay, Linawaan, Pago-onayan, Putian, and Sinibuyas.

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[1] Experiment Station contribution No. 130

b. With relatively short stalks.—Bolonganon, Inisarog, Laguis, Mininonga (C. A. 9274), Putianin.

c. With relatively small stalks.—Agutay, Bongulanon, Ihalas, Inusa, Kinalabao, Laguis (C. A. 10284), Lagurhuan- Dogami, Layahon, Luno, Mininonga, Moro, Pulahan, Putian, Sabaon, Samoro-puti, Sinibuyas, Sugmod, and Visaya.

d. With less than 140 roots round the hill.—Agogaron, Agutay, Bolonganon, Ihalas, Itehin-balud (C. A. 4273), Kinalabao, Laguis, Lagurhuan-Dogami, Maguindanao, Moro, Putian, Putianin, Sabaon, Makiling, Sinamoro, Sinanta-Cruz, and Sinibuyas.

DESIRABLE QUALITIES

Besides the *undesirable* qualities some of the varieties also possess qualities that may be considered as desirable. The following are from Table I:

a. With large and tall stalks.—Baguisanon-Lawaan, Libuton, Linawaan, and Maguindanao.

b. With more than 20 leaf-sheaths on each stalk.—Baguisanon-Lawaan, Bulao, Ilayas, Libuton, Sabaon, and Makiling (C. A. 10178).

c. With more than 150 roots on each mature plant.—Alman, Baguisanon-Lawaan, Lagurhuan-Burawen, Libuton, Linawaan, and Pagoonayan.

d. With roots as deep as one meter or more below the surface of the ground.—Alman, Baguisanon-basag, Bongulanon (C. A. 10291), Kinalabao, Lagurhuan-Burawen (C. A. 4275), Libuton, Mininonga (C. A. 10303), Pagoonayan, Pulahan, Putian, Sabaon, and Sinibuyas.

e. With more than 300 roots round the hill.—Baguisanon-basag, Kalado, Lagurhuan, Lagurhuan-Burawen, Pulahan, and Visaya.

FURTHER STUDY OF "DESIRABLE" AND "UNDESIRABLE" QUALITIES

It is interesting to note in Table I that although the criteria considered are few yet none of the varieties studied possess all the "desirable" qualities. Neither was a single variety found possessing all the "undesirable" varieties. Of the nine undesirable points only five were present in each of the very few varieties. The highest number of desirable points found in a variety was six or only 60 per cent perfect. From these data it is obvious that there is an extensive field for improvement of varieties. Such an improvement might be accomplished through selection, hybridization, and by an unexpected appearance of mutants, or sports. Following are some of the striking results given in Table I.

a. Possessing 4 or 5 of the undesirable qualities.—Agutay, Ihalas, Lagurhuan-Dogami, Moro, Putian, and Sinibuyas.

b. Possessing none of the desirable qualities for Los Baños conditions.—Agutay, Banguisan, Bolonganon, Ihalas, Inisarog, Inusa, Laguis, Lagurhaun-Dogami, Layahon, Libutanay, Luno, Mininonga, and Moro.

Comparing the two preceding lists of varieties we find that there are some varieties that possess the maximum four or five undesirable qualities at the same time possessing none of the desirable ones. They are Agutay, Ihalas, Lagurhuan-Dogami, and Moro. These may be considered truly undesirable, especially if we bear in mind that the varieties further possess the following points:

1. Agutay, with small stalks.
2. Ihalas, with small stalks and scanty root-system.

3. Lagurhuan-Dogami, a poor stooler, with small stalks and scanty root-system.

4. Moro, with small stalks and scanty root-system.

Table I shows also the following interesting data:

a. Possessing four, five or six desirable qualities.—Baguisanon-Basag, Baguisanon-Lawaan, Bulao, Itom, Lagurhuan, Libuton, and Sabaon.

b. Possessing none of the undesirable qualities.—Alman, Bulao, Kalado, Lagurhuan-Burawen, Libuton, Pongay.

The varieties Bulao and Libuton both possess the maximum number of desirable qualities and have none of the undesirable points. According to the criteria here employed these two varieties are exceptionally good. With the exception of Sabaon, the rest of the varieties included in the two immediately preceding lists are also good. The variety Sabaon has some undesirable qualities, namely, it produces small stalks and a scanty root-system, (See Table I). But Bulao was found by Reyes (1) to possess fiber with extremely low tensile strength and Libuton to produce fiber "not quite so white nor easy to strip" (2). It is obvious, then, that a variety may possess several of the desirable vegetative characters, hence it may appear to be suitable for extensive planting yet may yield fiber with certain undesirable qualities.

ROOT DISTRIBUTION

Like the rest of the vegetative structures of any plant the development of the root is greatly influenced by its environment. The type of soil, presence of rocks in it, and its moisture content are among the modifying factors. Roots growing in a clay soil may be expected to attain less perfect development than similar roots in a loam soil. Rocks may retard and distort the course of the growth of the roots. Both fertile and loose soil especially of volcanic origin are known to promote a full development of the root-systems of abaca while a soil comparatively poor in organic as well as inorganic substances is acknowledged to be capable of retarding development of the structure. However, in the present study the varieties were grown side by side on a piece of land scarcely one fourth of a hectare in area. The soil is deep and sandy loam in character. While the trenches were being dug it was found that the soil was fairly uniform in texture and free from anything that might hinder the development of the roots. It is then safe to assume that any difference in the distribution of the roots of the varieties studied was due mainly to natural varietal differences.

The number of roots found in successive horizontal layers five centimeters thick, beginning at the surface, varied according to varieties. Some varieties, Baguisanon-Lawaan and Libuton for instance, produced roots in the soil as deep as one meter from the surface. The Lagurhuan variety had more roots than any other variety shown in Table II. But its roots were not found below 85 centimeters. The Sabaon had a very scanty root-system. As shown in Table II abaca, like coconut (3) is somewhat of a surface feeder. A number of the roots from a hill was found within the first seven zones, or 35 centimeters below the surface of the ground. Most of the roots were found between the zones three and five. Because of this location of the roots care should be taken in the first cultivation of a plantation; for a deep cultivation may result in wholesale destruction of the roots of the plant.

The great practical value of detailed comparisons of this kind for the varieties in any given abaca district are apparent. It is of the highest possible importance to extend this more exact work to all abaca regions in connection with exhaustive studies of the character of the fibers of all the varieties, that are now being carried on.

SUMMARY OF CONCLUSIONS, FOR LOS BAÑOS CONDITIONS ONLY

(1) None of the varieties studied possess all the desirable qualities. Neither was a single variety found possessing all of the undesirable points.

(2) The varieties Agutay, Ihalas, Lagurhuan-Dogami, Putian, Moro, and Sinibuyas had the maximum four or five undesirable qualities. The yield of fiber and its qualities were not here considered.

(3) The varieties Baguisanon-Basag, Baguisanon-Lawaan, Bulao, Itom, Lagurhuan, Libuton, and Sabaon were found to possess the maximum number of desirable qualities. With the exception of Sabaon, which had some undesirable points, all of these varieties had none or practically none of the undesirable criteria employed.

(4) The varieties Bulao and Libuton, both possessing the maximum number of good points and at the same time having none of the bad points, might be considered good varieties. But the Bulao produces weak fiber and Libuton yields fiber "not quite so white nor easy to strip".

(5) Different varieties had different root-systems. Baguisanon-basag, Kalado, Lagurhuan, Lagurhuan-Burawen, Pulahan, and Visaya had more than 300 roots round the hill. If they possess other good qualities these varieties should be recommended for planting in places frequently visited by typhoon and drought.

(6) The varieties Agogaron, Agutay, Bolonganon, Ihalas, Itehin-balud, Kinalabao, Laguis, Lagurhuan-Dogami, Maguindanao, Moro, Putian, Sabaon, Makiling, Sinamoro, Sinanta-Cruz, and Sinibuyas had rather limited root-systems.

(7) Abaca is a surface feeder. Most of its roots may be found between 15 and 25 centimeters below the surface of the ground. Deep cultivation may injure most of the roots.

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TABLE I.—*Comparison of abacá varieties in certain vegetative features.*

			Undesirable qualities										Desirable qualities										
			Stalk		Stool				Plant				Stalk					Stool		Roots			
	Variety name	C. A. No.	Less than 1 meter in height	Less than 15 cm diam. at base	Less than 10 plants to the hill	More than 30 plants to the hill	Less than 200 cm circ at base	Without roots below 50 cm	Less than 140 roots around stool	Less than 6 leaves each	Less than 100 roots each	Total number of points	8 or more leaves	Most number to the hill	20 cm diam at base.	More than 3 meters high.	More than 20 leaf sheaths	Circ more than 300 cm at base	Circ more than 500 cm at top	More than 150 to each plant	As deep as or deeper than 1 meter	More than 300 around stool	Total number of points
1	Agoraron	9533							×		×	2	+						+				2
2	Agutay	4272		×			×		×	×		4											
3	Alman	10304											+							+	+		3
4	Alman nga itom	9272									×	1	+						+				2
5	Banguisan	9271			+							1											
6	Baguisanon-Basag	4270								×	×	2				+			+		+	+	4
7	Baguisanon-Lawaan	10308			×							1	+		+	+	+			+			5
8	Boñgulanon.	4284		×		×					×	3		+		+							2
9	Boñgulanon .	10291		×						×	×	3		+					+		+		3
10	Boloñganon.	11163	×				×		×			3											
11	Bulao	10298											+		+		+		+				4
12	Ihalas	9273		×				×	×		×	4											
13	Ilayas	10287									×	1	+				+		+				3
14	Inisarog	9524	×									1											
15	Inusa	4294		×							×	2											
16	Inusa	10305		×						×	×	3											
17	Itehin Balud	4273							×			1						+	+				2
18	Itehin Balud.	10289							×		×	2						+	+				2
19	Itom.	4293				×						1		+		+		+	+				4
20	Itom.	9529									×	1							+				1
21	Itom.	10302				×					×	2		+				+	+				3
22	Kalado.	4292											+					+	+			+	3
23	Kinalabao	11212		×					×		×	3									+		1
24	Kinosol.	10307									×	1							+				1
25	Laguis	4285	×		×				×			3											
26	Laguis	10284		×					×			2											
27	Lagurhuan.	9280									×	1	+			+		+				+	4
28	Lagurhuan Burawen.	4275																+		+	+	+	3
29	Lagurhuan Burawen.	10300													+					+			2
30	Lagurhuan Dogami	10295		×	×		×		×		×	5											
31	Layahon.	1030		×	×		×					3											
32	Libutanay	1033			×					×	×	3											
33	Libuton.	100													+	+	+		+	+	+		6
34	Linawaan.	4288			×					×	×	3			+	+				+			3
35	Luno.	10283		×						×		2											
36	Maguindanao.	4283							×	×		2		+	+	+							3
37	Makiling	10178							×		×	2					+						1
38	Mininoñga	9274	×									1											
39	Mininoñga.	10303		×							×	2									+		1
40	Moro	10297		×			×		×		×	4											
41	Pagoonayan	1035			×							1								+	+		2
42	Pinoonan	1029																+	+				2
43	Pongay.	9278																	+				1
44	Pulahan	4296		×						×	×	3	+								+	+	3
45	Punucan.	10296											+										1
46	Putian	11247		×	×				×		×	4				+					+		2
47	Putianin.	9152	×						×			2							+				1
48	Sabaon	9532		×					×		×	3	+	+			+		+		+		5
49	Sinaba	10310								×		1							+				1
50	Sinamoro	9277					×		×		×	3				+							1
51	Samoro-Puti	4279		×						×	×	3		+									1
52	Sinantacruz	9531					×		×		×	3		+					+				2
53	Sinibuyas	11213		×	×				×		×	4									+		1
54	Sugmod	4282		×						×		2		+				+	+				3
55	Sugmod	10293								×		1						+	+				2
56	Visaya	4286		×								1						+				+	2
57	Visaya	10286									×	1										+	2

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THE WAYS OF SCIENCE

The following excerpts on this idea were taken from an article by Edwin E. Slosson on *Science remakes the world* in *The World's Work*, March, 1923.

Notice that the revolutions of science are achieved without the use of arms or argument. Here we see cases where millions of people are affected and the course of history altered yet neither force nor propaganda is employed.

The scientist does not have to persuade or convince anybody. He either has discovered something or he has not. In either case his talking about it will make little difference. There is comparatively little debate nowadays in scientific circles over scientific questions, nothing like the time taken up by controversy in politics, theology, art, or literature. What discussion there is among scientists is mostly over modes of interpretation or rivalry in priority or the policy of the profession.

The method of science is economy of thought. The aim of science is control of the future. Science shows how these new forces can be acquired and managed and what benefits can be derived from their employment. But science has no authority to ensure that the world will make proper use of its gifts. Men may employ them for their own destruction. In fact they do.

In short, science provides the motive power, but not the motive for the use of power. Consequently the scientist should not be blamed when we see his well intended and valuable discoveries employed to increase the misery of the world instead of alleviating it.

Napoleon said:

> "The true conquests, the only conquests that cost no regrets, are those achieved over ignorance."

But like territorial conquests the conquests over ignorance may curse the conquerors if they are improperly employed.

But we must not stop the advance of knowledge for fear of the consequences. In the warfare of man with nature there is no truce. Unless man can turn the forces to his own advantage he will be crushed by them. Unless man can establish his supremacy and superiority over the world of nature he will sink again to the level of the brute from which he has risen.

As Matthew Arnold puts it in his

SONNET TO AN INDEPENDENT PREACHER

"Know, man hath all which Nature hath, but more,
And in that *more* lies all his hopes of good.
Nature is cruel, man is sick of blood;
Nature is stubborn, man would fain adore:
Nature is fickle, man hath need of rest;
Nature forgives no debt, and fears no grave;
Man would be mild, and with safe conscience blest.
Man must begin, know this, where Nature ends;
Nature and man can never be fast friends.
Fool, if thou can'st not pass her, rest her slave."

FEEDING EXPERIMENTS ON DRAFT CATTLE[1]: II

By Antonio C. Sanchez

There has been little comparative study of the different native feeds and forages suitable as supplement to native pastures for work bullocks in the Philippines. Lago[2] reported that supplementing native pastures with corn, varying from two to three kilograms of grain a day, for work bullocks of about 375 kilograms in weight, did not give any appreciable good effects (August 25, 1917, to October 19, 1917; October 20, 1917, to December 14, 1917; December 15, 1917, to January 14, 1918); of sugar cane and corn fodder used as supplements to native pasture, corn fodder was better than the Japanese cane, (using the whole plant; period of experiment, March 16, 1918, to April 26, 1918); and that Guinea grass (*Panicum maximum* Jacq.) was slightly better than corn fodder (August 17, to September 28, 1918).

The writer presents the following results of his study on the effect (1) on the weight, health, and ability to endure work of work bullocks on native pasture supplemented with shelled corn, compared with native pasture alone; (2) of native pasture supplemented with Guinea grass, compared with native pasture alone; and (3) of native pasture supplemented with copra meal, compared with native pasture alone.

These experiments were conducted at the College of Agriculture, University of the Philippines, Los Baños, Laguna, and covered a period of almost one year (235 days).

GENERAL PLAN

THE BULLOCKS

The animals used in this work were ten draft bullocks selected from the College herd. They were divided into two uniform lots of five animals in each lot. The animals of one lot were to receive one kind of supplemental feed in addition to what they could get in the pastures and those of the other lot were to depend entirely on what they could get in the pastures and the uncultivated and grassy lots of the College Farm. The animals from both lots were arranged in such a way that they could be worked in teams of two animals each. Each team was composed of animals from both lots, thus giving the animals the same kind of labor for the same length of time.

The ten bullocks were scheduled to work every day during the week, except Sunday, from half-past seven to eleven o'clock in the morning and from one o'clock to four o'clock in the afternoon. Exception was made when the weather did not permit work or when there were no laborers to handle the animals.

The bullocks were divided into two uniform lots as determined by the average weight of each animal for three successive weekly weighings. The initial weight of each animal was determined by taking the average weight of the animal one week before the beginning, at the beginning, and one week after the beginning

[1] Thesis presented for graduation from the College of Agriculture, No 158; Experiment Station contribution No. 131.

[2] Lago, Francisco. Feeding experiments on draft cattle. The Philippine Agriculturist 8:79-91. 1919

of the experiment; likewise the final weight was found by taking the average weight of the animal one week before closing, at the closing, and one week after the close of the experiment. The animals from both lots were weighed every week at about eight o'clock in the morning, before they were put to work.

The ten native bullocks used were carefully selected from the herd of work cattle of the College. They were almost uniform in size and age and could be used in teams of two animals each. As they had been properly cared for before the experiment and received excellent care during the study the bullocks were in good condition throughout the period of observation.

PLAN OF FEEDING

The general plan of feeding the bullocks in Experiments I, II and III was the same throughout. At eleven o'clock in the morning, whenever the animals were used, animals belonging to Lot I of each experiment were given the supplemental feed and those in Lot II were pastured in the grassy and uncultivated lots of the College Farm and left there until one o'clock. They were put to work again till four o'clock in the afternoon. Animals in both lots (I and II) were let loose in the same pasture for the night. The supplement given to each animal was weighed before giving; that which was left uneaten was weighed after each feeding. The animals from both lots were always given water after they were removed from the stable and pastures at one o'clock, just before putting them to work.

THE PASTURE

Of the six pastures of the College, the two known as Tungtungin and Pagitan were the ones used throughout the experiments. The grass areas are traversed by creeks where the animals could easily get access to water. The rest of the herd of work cattle were also in these pastures, grazing with the bullocks used in these experiments. The vegetation of the pastures, however, was properly maintained by transferring the animals from one pasture to another so as to avoid depleting the supply of feed (see Table I).

TABLE I.—*College native pastures.*

Name of place.	Vegetation [a]
Tungtungin	*Imperata cylindrica* (L) Beauv. *Saccharum spontaneum* L. *Andropogon halepensis* (L.) Brot. *Leucaena glauca* (L.) Benth. *Paspalum conjugatum* Berg. *Rottboellia exaltata* L. f. *Mimosa pudica* L.
Pagitan	*Imperata cylindrica* (L.) Beauv. *Paspalum conjugatum* Berg. *Saccharum spontaneum* L. *Andropogon halepensis* (L.) Brot. *Rottboellia exaltata* L. f. *Mimosa pudica* L. *Panicum sp.*
College Farm	*Paspalum conjugatum* Berg. *Imperata cylindrica* (L.) Beauv. *Saccharum spontaneum* L. *Rottboellia exaltata* L. f. *Panicum sp.* *Panicum flavidum* Retz. *Digitaria consanguinea* Gaudich. *Desmodium triflorum* (L.) DC. *Panicum colonum* L.

[a] Arranged according to their relative abundance, as identified by Mr N Catalan of this College

EXPERIMENTS AND RESULTS

EXPERIMENT I

Object.—The object of this experiment was to compare native pasture supplemented with corn (shelled) with native pasture alone.

Plan of the experiment.—This experiment was started on August 30, 1920, and lasted 85 days.

Lot I was given corn grain in addition to pasture.

Lot II was pastured.

At eleven o'clock in the morning whenever the animals were used, bullocks belonging to Lot I (Corn Lot) were brought to the stable and fed corn grain varying from one to five kilograms to the head.

The grain used.—Native Yellow Flint corn from the Department of Agronomy was used. The quality of the corn used throughout the experiment was poor as the corn was rather old and about 25 per cent of the kernels were attacked by corn weevils.

The pasture.—Most of the grass in the pasture was mature, but the rest of the vegetation was still good and palatable to the animals (see Table II).

Table II shows that Lot I (with grain supplement) had a total decrease of —11.0 kilograms or an average of —2.21 kilograms an animal. Lot II showed a total decrease of —48.34 kilograms or an average of —9.67 kilograms an animal.

These figures show that corn grain as supplement to native pasture was only slightly better than pasture alone. This corroborates Lago's results.

EXPERIMENT II

Object.—The object of this experiment was to compare native pasture supplemented with Guinea grass with native pasture alone.

Plan of the experiment.—This experiment was begun on May 16, 1921, and lasted 80 days. With the exception of bullock Abuhin of Lot I and Barroso of Lot II, the same animals were used as in Lots I and II of Experiment I. Pedro and Felipe were substituted for Abuhin and Barroso, respectively.

Lot I was fed Guinea grass in addition to pasture.

Lot II was pastured.

At eleven o'clock whenever the bullocks were used, a fresh supply of Guinea grass was given to the animals in Lot I in the stable, and those in Lot II were pastured in the grassy and uncultivated lots of the College Farm. The amount of Guinea grass given to each animal in the stable was recorded and any amount left uneaten was weighed and deducted from the total amount given. They were fed as much as 11.6 kilograms each time.

Feeds used.—The Guinea grass used in this experiment was taken from a field of Guinea grass on the College Farm. It was in the early part of the rainy season of this locality when this experiment was conducted. The condition of the Guinea grass and of other grasses of the College Farm was good.

The pasture.—The same pastures used in Experiment I were used in this experiment. The vegetation was abundant and succulent, as it was in the early part of the rainy season of this locality when this test was carried out (see Table II).

Table III shows that both lots increased in weight, the Guinea grass lot, 18.34 kilograms or an average of 3.67 kilograms, and the pasture lot, 33.78 kilo-

grams or an average of 6.76. The total amount of Guinea grass fed was 678.60 kilograms.

It was observed that the bullocks relished the Guinea grass, but as soon as the stalks became mature, consequently hard and coarse, the animals refused to eat the greater part of the stalks.

The animals in both lots depended entirely upon roughage as their source of food supply. Animals in Lot II had a greater increase in weight than those in Lot I, apparently because they had a better chance to secure a variety of feeds in the pastures than those in Lot I which were fed in the stable with Guinea grass. Animals from both lots increased in weight except Kaiser of Lot I and Dupong of Lot II.

There seemed to be no advantage in supplementing native pastures with Guinea grass for working bullocks when they are in good condition.

EXPERIMENT III

Object.—The object of this experiment was to compare native pasture supplemented with copra meal with native pasture alone.

Plan of the experiment.—On August 22, 1921, this experiment was begun and it was closed on October 3, 1921, covering a period of 70 days.

Lot I was fed copra meal in addition to pasture.

Lot II was pastured.

At eleven o'clock in the morning whenever the animals were used, animals in Lot I were given copra meal which ranged from about one to one and one-half kilograms a head. The copra meal was given in wet mash and so any amount left unconsumed was not weighed because of the addition of water. The feed was always dusted with salt, so as to increase its palatability. Animals in Lot II were pastured in the grassy and uncultivated lots of the College Farm.

Feeds used.—The copra meal used in this experiment was fresh and of good quality.

The pasture.—The same pastures used in Experiments I and II were used in this test. Most of the grasses were rather mature, but the rest of the vegetation was good and succulent. (see Table IV).

From the results from both lots as given in Table IV, it may be seen that the copra lot had the greater decrease in weight, —23.23 kilograms, or an average of —4.64 kilograms an animal, while the pasture lot had a decrease of —14.19 kilograms or an average of —2.84 kilograms an animal.

Copra meal was not palatable to these animals; hence, they could not consume much of this feed. The grasses in the pastures were mature and coarse during this experiment.

It is apparent that in maintaining the weight of work animals giving copra meal as a supplement to native pasture did not give any advantage over native pasture alone that was in a relatively poor condition of vegetation.

SUMMARY OF CONCLUSIONS

1. Under the present test, shelled corn fed in amounts varying from one to five kilograms a head, as supplement to native pastures, proved to be a little better than poor stand native pastures alone in maintaining the weight and health of work bullocks.

2. Guinea grass, varying from 4 to 11.6 kilograms a head as supplement to native pastures did not show any special advantage over well conditioned native pastures alone, in maintaining the weight, vigor and health of work bullocks.

3. Copra meal, ranging from one to one and one-half kilograms a head, as a supplement to native pastures, did not show any advantage over poorly vegetated native pasture alone, for maintaining the weight, health, and working ability of work animals. Copra meal was not palatable to these animals.

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The writer wishes to express here his obligations to Professor B. M. Gonzalez, Head of the Department of Animal Husbandry, and to Mr. M. Mondoñedo, Instructor in Animal Husbandry, for their valuable suggestions and criticisms during the progress of the experiments.

TABLE II.—*Summary table of weights and feed given.*

Lot I (Corn Lot).

	Initial weight.	Final weight.	Gain.	Loss.
1. Animals:	*kg.*	*kg.*	*kg.*	*kg.*
Kaiser	492.42	485.60		—6 82
Juan	412 57	426 82	+14 25	
Pintaro	472.12	472 87	+ 75	
San José	408.18	406 36		—1 82
Abuhin	373 47	356 05		—17 42
2. Total	2158 76	2147 70	+15 00	—26 06
3. Difference				—11 06
4. Average	431 75	429 54		—2 21

5. (a) Total feed eaten = 348.60 kg.
 (b) Average feed eaten = 69 72
6. Number of days of experiment = 85[a]
7. (a) Total days worked = 225
 (b) Average days worked = 45

Lot II (Pasture Lot).

	Initial weight.	Final weight.	Gain.	Loss.
1 Animals:	*kg.*	*kg.*	*kg.*	*kg.*
Lucio	489 39	463 03		—26.36
Maximo.	440 00	428.33		—11.67
Malukong.	423 03	421.21		—1.82
Barroso.	466 06	453 03		—13.03
Dupong.	364 55	369.09	—4.54	
2. Total.	2183 03	2134 69	—4 54	—52 88
3. Difference.				—48 34
4. Average	436 61	426.94		—9 67

5. (a) Total feed eaten
 (b) Average feed eaten
6. Number of days experim nt = 85[a]
7. (a) Total days worked = 225
 (b) Average days worked = 45

[a] August 30, 1920, to November 22, 1920.

TABLE III.—*Summary table of weights and feed given.*

Lot I (Guinea grass Lot).

	Initial weight	Final weight.	Gain.	Loss.
	kg.	*kg.*	*kg*	*kg.*
1. **Animals:**				
Kaiser	489 70	479 24		—10 46
Juan	422 57	427 24	+4 67	
Pintaro	473 03	482 72	+9 69	
San José	432.73	438 78	+6 05	
Pedro	400 39	408 78	+8 39	
2. **Total**	2218 42	2236 76	+28 80	—10 46
3. **Difference**			+18 34	
4. **Average**	443.68	447 35	+3 67	

5. (a) Total feed eaten = 678.60 *kg.*
(b) Average feed eaten = 137.70
6. Number of days of experiment = 80 [a]
7. (a) Total days worked = 210
(b) Average days worked = 42

Lot II (Pasture Lot).

	Initial weight.	Final weight.	Gain.	Loss.
	kg.	*kg.*	*kg.*	*kg.*
1 Animals:				
Lucio	453.78	467 12	+13.34	
Maximo	410 16	447.87	+37.71	
Malukong	430 60	434 09	+3.49	
Felipe	422 88	429.24	+6.36	
Dupong	390 30	363.18		—27 12
2 Total	2107 72	2141 50	+60.90	—27 12
3. Difference			+33 78	
4. Average	421 54	428 30	+6.76	

5. (a) Total feed eaten
(b) Average feed eaten
6. Number of days of experiments = 80
7. (a) Total days worked = 210
(b) Average days worked = 42

[a] May 16, 1921, to August 3, 1921

TABLE IV.—*Summary table of weights.*

Lot I (Copra meal Lot).

	Initial weight.	Final weight.	Gain	Loss
	kg.	*kg.*	*kg*	*kg*
1. Animals:				
Kaiser	494 09	491 62		—2 47
Juan	423 33	421 82		—1 51
Pintaro.	478 18	484 09	+5 91	
San José	432 12	419 09		—13 03
Pedro	408 79	396 66		—12 13
2. Total.	2236 51	2213 28	+5 91	—29 14
3. Difference				—23 23
4. Average	447 30	442 66		—4 64

5. Number of days of experiment = 70 [a]
6. (a) Total days worked = 225
(b) Average days worked = 45

Lot II (Pasture Lot).

	Initial weight.	Final weight.	Gain.	Loss.
	kg.	*kg.*	*kg.*	*kg.*
1 Animals:				
Lucio	469 24	465 15		—4.09
Maximo.	445 45	437 27		—8 18
Malukong.	429 09	422 72		—6 37
Felipe.	426 36	418 48		—7 88
Dupong.	363 42	375 75	+12 33	
2. Total	2133 56	2119 37	+12 33	—26 52
3. Difference.				—14.19
4 Average	426.71	423 87		—2.84

5 Number of days of experiment = 70
6. (a) Total days worked = 225
(b) Average days worked = 42

[a] August 22, 1921, to October 30, 1921

RICE ON COGON SOIL WITH AND WITHOUT TREATMENT[1]

By QUIRICO F. ABRAJANO

INTRODUCTION

PROBLEM

There are in the Philippines extensive areas covered with cogon (*Imperata cylindrica* Linn.) which might be devoted to rice growing. Much of the cogon land that is on the hillsides is cleared up under the *caiñgin*[2] practice and planted to rice. A belief prevails that rice planted directly after cogon has poor growth and low production of both straw and grain, especially the first crop. It should be of interest to know what effect cogon has, if it has any, on the rice crop following it.

PREVIOUS WORK ON THE SUBJECT

Zamora (1), Balangue (2), Goco (3), Trelease and Paulino (4), Vibar (5), and Trelease (6), performed a number of experiments on the fertilization of upland rice at this College. None of these, however, were carried out on cogon soils. The only work on cogon soil which has been reported, thus far, is that of Navarro (7), but he used corn instead of rice as the crop.

Navarro ran two sets of cultures using earthen pots holding five kilograms of soil each, as containers. In the first culture he used ammonia-leached soils, water-leached soils, burnt soils, and normal soils. Three pots were treated with metallic stimulants. In his first culture he used these chemicals, single and in combination: potassium nitrate, dicalcium phosphate, magnesium sulphate. In the second culture he used the following as fertilizers: chemicals, K_2SO_4, $NaNO_3$, Na_2HPO_4, $CaCO_3$, Na_2SiO_3; manures: stable manure and worm excrement. The conclusions reached in the experiment were that (a) lime was decidedly beneficial to the cogon soil; (b) that the cogon soil was deficient in nitrogen; and (c) that the application to stable manure resulted in much more active growth.

OBJECT OF THE PRESENT WORK

The objects of the present experiment were, (1) to determine the effect, if there is any, on the production of straw and grain, of cogon plant preceding the rice crop, and (2) to find the treatment of the soil that would best improve its productiveness.

TIME AND PLACE OF THE PRESENT WORK

This work was carried out during the rice season of 1921-1922 at the College of Agriculture, University of the Philippines, Los Baños, P. I.

MATERIALS

The soil used in the experiment was a silt loam and was taken to a depth of thirty centimeters from a cogon area. The soil was pulverized and then sampled for analysis.

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[1] Thesis presented for graduation from the College of Agriculture, No. 159; Experiment Station contribution No. 132.

[2] A *caingin* is a temporary clearing on which rice, corn, or vegetables are planted in a crude, primitive manner.

The containers were kerosene cans. To provide for drainage, holes were made in the bottom. About 18 kilograms of soil were put into each container.

The fertilizers used in the different treatments were lime, manure, kainit, dried blood, ammonium sulphate and double superphosphate. In addition, a crop of green manure and all plant residues, except when otherwise stated, were turned under.

Two crops were harvested. The variety of rice used was Tiniaong, bearing the College No. 9118F[3]. It is an early variety, maturing in about one hundred days. The seeds were obtained from the Agronomy Department. The seeds of mungo which was grown and turned under as green manure were obtained also from the same department.

EXPERIMENTS AND RESULTS

ANALYSES OF THE SOIL

Both mechanical and chemical analyses of the soil were made. In the mechanical analysis, the centrifugal method devised by the United States Bureau of Soils (8) was employed, and the size of particles for the separates was adopted.

In the chemical analysis, the total, instead of the acid soluble elements, was determined. The methods used were those employed at the Illinois Agricultural Experiment Station. The following elements were determined: nitrogen, phosphorous, potassium, calcium and magnesium. Moisture and organic matter were also determined. The soil gave an alkaline reaction. Table I shows the results of the mechanical and the chemical analyses.

TABLE I.—*Analyses of soil.*

Mechanical.			Chemical.		
Separates.	Size.		Elements and other constituents.		Kilograms per hectare.
	mm	*per cent*		*per cent*	
Fine gravel	2-1	35	Moisture	7 7	
Coarse sand	1-0.5	9 13	Organic matter.	10 43[a]	
Medium sand.	5- 25	10 19	Nitrogen	.082	2050[b]
Fine sand	.25-.10	17 74	Phosphorus.	227	5675
Very fine sand.	.10- 05	24.75	Potassium.	496	12400
Silt	05- 005	30 25	Calcium.	2 185	54625
Clay[c].	005-9	7.59	Magnesium	1 667	41675

[a] Calculated on the free moisture basis

[b] Calculated on the basis of 2500000 kilograms of soil to the hectare twenty centimeters deep.

[c] By difference

CULTURE

The plan was to grow a crop of legume (mungo, *Phaseolus radiatus*, Linn) first, and then turn this under as a green manure. Five mungo plants were allowed to grow in each pot, and when the flowers began to appear they were all turned under. In some parts, the crop was dried before turning under. The crop was analyzed and found to contain 1.05 per cent nitrogen as calculated on the dry basis.

This crop of mungo was followed by the first crop of rice. The seeds were sown on August 5, 1921, and the crop was harvested on November 9 of the same year. The culture covered a period of ninety-six days. Four plants were allowed to grow in each pot. At harvest the height of the plants was recorded, and the fresh and dry weights of the straw as well as the weights of both fresh and dry heads and the weight of the grain were taken. Table II shows the result of the first crop.

The second crop of rice followed the first, but the soil was given different treatment. Lime, kainit, dried blood, ammonium sulphate, double superphosphate, and manure applied singly and in combination were used as fertilizers. The culture covered a period of ninety-five days. The treatment given to the soil and the data obtained from the crop are given in Table III.

DISCUSSION OF RESULTS

ANALYSES OF THE SOIL

The physical composition of the soil, a silt loam, showed that it is not heavy and would be easy to work with. Brown and Arguelles (9) made a mechanical analysis of some grass land on Mount Maquiling at the foot of which the College is situated and found the soil to be loamy clay.

The physical and chemical conditions of the soil are factors in soil fertility A soil may be in good tilth, yet, if there is not enough available food a normal crop cannot be raised. On the other hand, a large stock of plant food in the soil may not produce a good crop if the physical condition is not suitable for the growth of the crop. Table I shows that, so far as physical composition is concerned, the soil under consideration should produce a good crop. But examination of the amount of some plant foods present reveals the fact that, at least one essential element is deficient. The amount of nitrogen for example, while seeming large, 2050 kilograms to the hectare, does not appear, as will be shown later, to be sufficient to meet the need of the crops. Potassium, too, does not appear to be plentiful in the soil, but phosphorus, calcium, and magnesium are high. The fact that the reaction of the soil was strongly alkaline indicates that calcium and other alkaline earth and alkali salts may be present in large quantities. Brown and Arguelles (9) also analysed, chemically, some of the grass lands on Mount Maquiling and found that they contain .15 per cent nitrogen, .12 per cent phosphorus, .61 per cent calcium, .37 per cent magnesium and .21 per cent potassium. These determinations however, being partial, are not comparable with the present data, which are total.

CROPS

First culture.—As stated, the first crop of rice followed the turning under of the mungo, as green manure. Three pots were set aside for control and 46 pots were planted to mungo. In five duplicates, the legumes were allowed to dry before turning under, while in the rest they were turned under fresh. The amount of green manure turned under when dried was 11.4 grams per pot and, when fresh, 51.63 grams per pot. In Table II are given the effect of this treatment of the soil on the growth and yield of straw and grain. The crops growing in pots with dried legumes turned under were superior in every case and in every respect to the untreated pots. On the other hand, those growing in the pots where fresh legumes had been turned under were generally superior to the crops

in pots with dried legumes. For the control, the average height was 71.47 centimeters; weight of dry straw, 16.95 grams; and grain, 9.41 grams. In pots with dried legumes the average height was 75.31 centimeters; weight of dry straw, 17.01 grams; and grain, 10.18 grams. In pots with fresh legumes the average height was 77.91 centimeters; weight of dry straw, 17.77 grams; and weight of grain, 11.00 grams. It is apparent from these figures that green manuring in this type of soil improves the growth and yield of both straw and grain of rice. The yield of grain was increased 17.4 per cent by the turning under of fresh legumes. This is in general agreement with the results obtained by Krauss (10), who found an increase of yield from poor paddies when treated with green manures. It may be added that the fresh legumes were more effective than the cured ones in improving the yield in this type of soil. This is because fresh legumes are more readily decomposed than the cured ones, thus making the plant available to the crops.

These results follow the common observation that rice grown immediately after the cogon has poor growth and low production of straw and grain.

Second culture.—Comparing the plants in control pots for the first and second crops (see Tables II and III) it will be seen that the first crop was much better in growth and production of straw and grain than the second. This difference shows the tendency of the succeeding crops to decrease and disproves, at least with the soil under experiment, the assertion that on cogon soil only the first crop of rice suffers from effect of the grass. The crop immediately following the first on soil without any further treatment was poor, much poorer than the preceding one. This indicates that the beneficial effect of the green manure was confined to the first crop, alone, and that in order to maintain or improve the yield of the succeeding crops, further appropriate treatment should be given to the soil. The interesting results on the rice plants from the various treatments given to the soil in this experiment are shown in Table III.

In the chemical analysis of the soil, the writer found that the nitrogen content was 0.082 per cent which, as stated before, is probably not sufficient to meet the demands of the crop. This statement was supported by the yield both of straw and grain. In general, the application of nitrogenous manure, either singly or in combination with phosphatic or potassic fertilizers, was accompanied by luxuriant growth and high yield of straw and grain. One exception was the treatment with ammonium sulphate (see Table III). When this chemical was applied either singly or in combination with lime and double superphosphate it injured, rather than improved, the productiveness of the soil. When applied alone, or in combination with double superphosphate, only a few grains were produced and the plants, though dark green in color, were so weak that they could not stand straight. And when nitrogenous manure was applied in combination with double superphosphate and lime the worst effect on the crop was obtained. The rice failed to grow more than twenty centimeters above the surface of the soil, and no grains were produced. This bad effect may have been due to the liberation of a large amount of ammonia the odor of which was noticed during the mixing of lime and ammonium sulphate.

The results with ammonium sulphate in this experiment are not in agreement with those of Trelease (6) and Goco (3). Both these investigators were working on two different types of soil from the College Farm. They found that

the high proportion of ammonium sulphate to another salt gave high yield of tops and grains. It is possible that the application of 140 grams of ammonium sulphate was too large a dose; but Vibar (5) using the same rate of application with another type of soil found ammonium sulphate to have increased, greatly, the production of rice straw and grain. Evidently, what is a good treatment for one type of soil is not necessarily good for another type.

Another exception to the good effect of nitrogenous manures on the rice crop was that of plant residues. Residues of a rice crop would naturally contain nitrogen besides the other plant foods obtained from the soil, and when turned under should furnish nitrogen to the crops. But results obtained from Pots 5 and 28 treated with residues, alone, did not give good yield. Plant residues, however, combined with kainit and double superphosphate gave a very high yield. The weight of grain obtained from pots with this combination was the third heaviest in the whole series. In combination with double superphosphate, kainit, and lime, it, also, gave high yields. These results led the writer to conclude that plant residues, alone, or in combination with kainit cannot improve the productiveness of the soil under investigation. On the other hand, when combined with some suitable materials, they may give increased production of rice.

The two other sources of nitrogen used in this experiment were horse manure and dried blood, both organic materials.

All pots receiving manure gave high yields. Balangue (2), using different kinds of chemical fertilizers and stable manure, found that for both lowland and upland rice, horse manure proved to be the best; the yield from pots receiving this manure being the highest.

With dried blood, the yields were generally the best, whether applied alone or in combination with phosphatic and potassic fertilizers. The tallest plant and the heaviest yield of grains were obtained from pots receiving dried blood and double superphosphate and dried blood and kainit.

The results of the nitrogen series plainly show that the soil under question readily responds to nitrogenous fertilization. This can lead to but one conclusion and that is that this soil is deficient in nitrogen, for while in some types of soil the use of ammonium sulphate proved to be beneficial it did not in this type. But even admitting it to be beneficial the use of ammonium sulphate for this or other types of soil experimented with at the College is not a practical proposition. The price of this fertilizer is ₱178.00 per ton short c. i. f. Manila (11). This price would prevent the cultivators of cogon lands from improving them with ammonium sulphate.

The organic sources of nitrogen proved to be the best for this type of soil, a fact which indicates the need of organic matter in the soil. Of the three organic materials used, dried blood proved to be the most efficient source of nitrogen. Vibar (5) found this to be true, also. From these results it would seem justifiable to recommend the use of dried blood for the improvement of cogon lands. But, again, the price of dried blood,—₱164.80 per short ton c. i. f. Manila (12)—, is beyond the means of cogon land cultivators. Such being the case, the question as to how the cogon land can be improved arises. The writer found that plant residues, alone, cannot improve it. If the planters use residues in combination with the fertilizers, furnishing elements lacking in the soil, such as potassium or

phosphorus, they would have to buy them in the market, and, as stated before, the price is higher than the average farmer can pay. But horse manure or other kinds of organic fertilizers are available for many planters, and if they would apply it to the land it would greatly improve the productiveness of the soil. If this is not possible still another means can be resorted to. It has been shown in this experiment that green manuring with this type of soil improved the yield of rice. Why should it not be practiced? Green manuring is not well understood in this country. While the yields obtained from such a practice are probably not so high as those obtained from the use of dried blood, they would certainly be much higher than the yields without the green manure treatment; and the cost of producing these better crops would be very low.

It may be seen in Table I that the potassium content of the soil used in this work is 0.496 per cent, which is rather low. It is not only low but it is probably usually in a form not available for plants. The results obtained from pots receiving kainit in combination with other fertilizing materials show that the soil responds to potassic fertilization. The second and third best yields obtained in the whole series were those from pots receiving kainit and dried blood; kainit and double superphosphate; and plant residues, respectively. These results, however, do not conclusively prove that the soil is deficient in potassium. It is likely that a large part of the potassium in the soil is in the unavailable form. In this case the question would narrow down to the treatment of the soil which would liberate the potassium salt or salts from the unavailable state. Such a treatment is found in the mixture of dried blood and double superphosphate. It can be said, then, that while the application of potassic fertilizer may increase the fertility of the soil in question, the maintenance or increase of organic matter in the soil would be more important and economical in the end.

The results obtained from the phosphatic fertilizer and of lime in combination with other fertilizers are so varied and inconsistent that to attempt to make any interpretation of them would be unwise. The analysis of the soil, however, shows that the phosphorus and calcium are very high, and they cannot be the limiting factors in this soil, but they may be present in the soil largely in unavailable forms, hence the crops raised may not be the maximum. The most important question then in the case of phosphorus is how to render it available in larger amounts to the crops at any time. We have seen in this experiment that dried blood and manure applied to the soil produced maximum crops even if no phosphorus or potassium is included. This means that with plenty of organic matter in the soil the phosphorus and potassium present are made available. Hence, the importance of maintenance or increase of organic matter in the soil.

SUMMARY AND CONCLUSIONS

The physical composition of cogon soil shows that other factors being favorable, it is fitted for the production of a good crop.

Chemical analysis revealed the fact that the phosphorus, calcium, and magnesium content of the soil are high, while the nitrogen and potassium content are rather low. Cultural results showed that while potassium is low and the soil responded to potassic fertilizers, potassium cannot be a limiting factor. Nitrogen, on the other hand, was deficient and was the limiting factor.

While with some types of soil investigated at the College, ammonium sulphate was beneficial to the crop, even with the rate of application used in the

present experiment, it proved to be injurious to the crop grown in the cogon soil under investigation.

Of the different sources of nitrogen applied to the soil, the organic kinds gave more satisfactory returns than the other sources. This shows that the soil is badly in need of organic matter.

Of the organic materials used, dried blood proved to be the most efficient, but it cannot be recommended for use by the cultivators of cogon lands because of its high price.

Cultural results showed that the rice crop following the cogon was poor, indicating that cogon preceding this grain has a bad effect on the rice, and confirming, at least in this experiment, the belief that rice immediately following the cogon has a poor growth and low production of straw and grain. Results further showed that the second crop of rice on the untreated soil was poorer than the first, thus disproving the claim that only the first crop suffers from the effect of cogon.

Green manure turned under improved the productiveness of the soil, the fresh plants being more effective than the dried.

Plant residues, alone, did not improve the yield of rice.

From the analysis of the soil, it was found that the organic matter content of the soil, 10.43 per cent, was rather high. This included the roots of cogon left in the soil. The fact, however, that the addition of organic materials to the soil resulted in the highest yield of rice, showed that a very large portion of this organic matter was present in an inert form. This matter was old roots and grass stems which decomposed too slowly to be used by the crops. That the soil may become highly productive, the addition of fresh organic matter should be made. Dried blood has been found to furnish this kind of organic matter but the price is so high that other organic materials must be used. If stable manure is available it should be used. If it is not available, green manuring should be resorted to. This was found to improve the productiveness of the soil under investigation and the writer believes that it will produce good results under field conditions. Green manuring is practiced with success in many countries, and there is no reason why it should not succeed in the Philippines. The writer suggests that it should be tried under field conditions.

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TABLE II.—*Result of first crop of rice.*

Series number.	Treatment.	Height.	Average weight of straw.		Average weight of head.		Average weight of grain.
			Fresh.	Dry.	Fresh.	Dry.	
		cm.	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*
1	Control....	70.48					
22 ..	Control... . .	70.95	30 6	16 95	11 6	10 01	9.41
37	Control.	73 00					
2 and 25.	Green manure..	78 36	33 75	17 45	13 55	11.70	11.10
4 and 27.	Green manure. .. .	78 81	37 80	18 20	13 61	12 03	11 37
7 and 30.	Green manure.. .	77 07	37 25	19 65	13.76	12 27	11.67
10 and 33.	Green manure.....	79 62	32 30	17 70	13 68	11 97	11 34
11 and 34.	Green manure... .	81.06	38 13	18 00	11 14	11 96	11 25
12 and 35.	Cured green manure	73 34	28 84	14 95	11.54	9 90	9 41
16 and 40.	Cured green manure	77.19	43.00	22 77	15 75	13 74	13 02
3 and 26	Cured green manure	70 68	21 96	11 80	8 42	7 28	6 66
48 and 49.	Cured green manure	76 98	35 90	17.05	12 83	11 67	10 97
8 and 31.	Cured green manure	78 38	36.80	18 48	12.95	11 43	10 83
13 and 36.	Green manure... .	76 00	33 83	17 13	12 90	11 63	11 13
15 and 39.	Green manure. ..	77 80	35 35	15 98	11 96	10 63	10 06
18 and 42.	Green manure.....	81.56	36 28	19.08	14 03	12.40	11.63
20 and 44.	Green manure.... .	78.28	30 40	17.20	14.00	12 54	11 98
5 and 28.	Green manure.....	74 47	31 56	15 38	9 85	9 03	8 43
6 and 29.	Green manure..	78 00	36 25	18.90	12.40	11 03	10 41
17 and 41.	Green manure. ..	74.48	40.56	18 38	13.45	11 25	10 62
9 and 32.	Green manure.. ...	82 61	37.16	17 50	14 37	12.63	11 98
19 and 43.	Green manure....	80 54	37 38	19 28	13 11	11 49	10 88
14 and 38.	Green manure.. .	79 18	38 66	18 68	14 28	12 37	11 69
23 and 46.	Green manure... ..	73 88	30 55	17 63	13 02	11 65	11 17
24 and 47.	Green manure......	75 69	31 48	18 00	14 03	12 28	11 65
21 and 45.	Green manure. ...	75.08	29 25	15 78	12 77	11 19	10 64

TABLE III.—*Result of second crop of rice.*

Series number.	Treatment. [a] D. B.	K.	D. S. P.	L.	A. S.	M.	P.R.	Average height.	Average weight of straw. Fresh.	Dry.	Average weight of head. Fresh.	Dry.	Average weight of grain.
	gm.	gm.	gm.	gm.	gm.	gm.		cm.	gm.	gm.	gm.	gm.	gm.
1 . . .	C	o	n	t	r	o	l						
22. . .	C	o	n	t	r	o	l	62 64	23.96	10.80	8 48	7.52	6 66
37 .	C	o	n	t	r	o	l						
2 and 25.	140							85 80	107 25	59.98	31 15	27 08	19 42
4 and 27.	140	140						96.35	116 50	55.50	34 47	28 50	23.66
7 and 30.	140		140	140				93 29	116.70	60 00	30 15	27 10	22 06
10 and 33.	140	140	140	140				92.73	133.60	71 33	30 15	25 47	19 38
11 and 34.	140		140					96.06	116.15	72 28	36.50	32 30	24.83
12 and 35.	140		140	Cured mungo [b]				92.98	130.65	71 10	33 45	27 34	20 90
16 and 40.	140		140	140 Cured mungo [b]				82.93	99 65	49.33	29 80	25 35	21 39
3 and 26.	No further treatment [b]							66.29	22 92	11 14	7 60	6 52	5 67
48 and 49.	No further treatment [b]							67.88	26 45	10.71	9.43	7 98	6 90
8 and 31.	Cured mungo [b]					500		78.11	53 20	21.84	16 37	13 81	11 78
13 and 36.		140				500		78.03	47.43	20.35	16 09	13.43	11 50
15 and 39.		140	140			500		86 11	56.53	33.08	20.23	18 80	16.09
18 and 42.			140	140		500		88 91	67 43	32 76	28 18	25 23	22.53
20 and 44.		140	140	140		500		84 83	83 63	39.98	26 59	23 05	19 74
5 and 28.							P.R.	67.10	20 73	11 13	6 50	5.49	4 75
6 and 29.		140					P.R.	74 75	35.07	15.43	9.50	7 92	6.53
17 and 41.			140				P.R.	83.87	62.63	34.63	25 51	23 15	19 68
9 and 32.			140	140			P.R.	80.97	70.13	30.63	21.87	19 21	16 85
19 and 43.		140	140				P.R.	93.63	80.35	36.74	31 25	27.00	23.61
14 and 38.		140	140	140			P.R.	85.96	70.38	33.35	22.60	19.21	16.18
23 and 46.					140			71 68	49.92	25.96	12.70	9 20	6 90
24 and 47.			140		140			77.12	10415	64.99	7.30	5.62	.50
21 and 45.			140	140	140			Failed to grow more than 20 centimeters.					

[a] D B =dried blood; K=kainit; D.S.P =double superphosphate, L=lime; A.S.=ammonium sulphate; M= horse manure; P R =plant residues.
[b] Cured mungo turned under before first crop

A SURVEY OF POULTRY DISEASES IN LOS BAÑOS[1]

By F. M. FRONDA
Of the Department of Animal Husbandry.

In the early part of 1918, the writer started to keep a careful record of all chicken diseases occurring in the flocks at the College of Agriculture and in those of some private individuals in the immediate neighborhood. The causes of a great number of the diseases recorded are largely controllable. For this reason it was thought that the publication of the data on file, though incomplete, might be of practical value to poultry raisers.

Up to August, 1919, all post-mortem examinations were made by the writer and *Diseases of poultry* (1) was frequently consulted in the diagnosis of the cases. Since 1919, most of the dead birds brought to the Poultry Division for examination have been sent to the College of Veterinary Science, and copies of their autopsy reports kept for the files of this division. The work is being continued and it is hoped that a more extensive report on this subject may be published in the future.

DISEASES OF THE RESPIRATORY SYSTEM

Under this heading, all diseases affecting the nasal passages, the pharynx, trachea, lungs, and air sacs are included.

ROUP

This disease is locally known as *sipon*. It is one of the most common troubles among the fowls in Los Baños and has been for some time the principal cause of death of the young pure-bred fowls in the College. Sometimes roup is used to designate a simple cold or catarrh, but, specifically, the disease is a contagious catarrh. It is distinguished by a sticky discharge from the nostrils, and in most cases, this discharge collects in the nasal sinuses where it forms a cheesy mass causing a tumor-like swelling of the face beneath the eyes. During the early stages, the discharge is thin and watery, but after a few days becomes thick. The appetite is diminished, the wings droop, and in general appearance, the bird shows signs of depression and illness.

Very few of the affected individuals recover; some gradually become weaker and live for months, during which time they spread the disease. Roup is very common during the rainy season. Young fowls are much more susceptible than the mature ones. The causal organism of this disease is not very well known, and it is the subject of much controversy. It is probably spread from one individual to another in a flock through the particles of dried secretion in the air or through the contamination of the food and drinking water. Birds that are out of condition are more easily attacked than the vigorous and properly nourished individuals.

Prevention is the best treatment for this disease. Before introducing new birds into a flock, isolate them until you are sure that they will not develop it.

[1] Experiment Station contribution No. 133

The flocks that are already infected should be quarantined and care should be taken not to use any material that has been used in infected yards. Any bird showing symptoms of the disease should be isolated at once, and those that die should either be burned or buried deep. Individual treatment requires a great deal of time, hence is not practicable for ordinary stock. In case of expensive birds, however, it is advisable. The following recommendation of Harrison and Streit (2) was tried in this College and found successful when the disease was treated during its early stages. "The nostrils are pressed together between the thumb and the forefinger in the direction of the beak two or three times. Pressure should also be applied between nostrils and eyes in an upward direction. This massage helps to loosen the discharge in the nostrils and eyes. The bird's head is then plunged into a solution of permanganate of potash (1 to 2 per cent)[2] for 20 to 30 seconds, in fact the head may be kept under the solution as long as the bird can tolerate it. The solution is thus distributed through the nostrils and other canals and has an astringent and slight disinfecting action. This treatment should be given twice a day and continued until all symptoms have disappeared." A solution of creoline one-half to one per cent has also been tried with equal success.

AVIAN DIPHTHERIA

This is locally known as *sampaga*. It is common among the mature fowls. The specific causative organism of this disease is not yet definitely settled, as Moore (3), Marshall (4), Mack (5), and Jackley (6) each have failed to isolate it.

When the disease is in its early stage of development the affected birds appear to be in good condition, and cannot be distinguished from the non-infected individuals except by the presence of diphtheritic deposit on the mucous surface of the nostrils, eyes, mouth, throat, trachea, or bronchi. At first this deposit is thin and light in color, later it becomes thicker, firmer, and more adherent. This deposit is called a false membrane and has the appearance of a flower, hence its local name, *sampaga*. When removed, the mucous membrane beneath is seen to be inflamed, ulcerated, and bleeding. During the later stages of the disease, the inflammation extends to the adjoining surface, the breathing is obstructed, the bird swallows its food with difficulty, the eyelids are stuck together, and a characteristic foul odor is noticeable. The affected birds become weak, emaciated, and death follows.

The modes of infection are the same as with roup, and the same general preventive measures recommended under roup should be followed in guarding against diphtheria. Local treatment of the diseased parts with a disinfectant has been found effective. The false membranes are removed and the inflamed tissues painted with tincture of iodine, silver nitrate or a strong solution of hydrochloric acid, care being taken not to touch the healthy tissues as they are likely to become infected. Experienced keepers of game cocks claim that they have had success by treating these diphtheritic tissues with the solution resulting from dipping a copper coin in vinegar and allowing it to stand over night. This has not been tried in the College and hence is not recommended[3].

[2] Words in parenthesis were inserted by the writer

[3] When a copper coin is dipped in vinegar (acetic acid), acetate of copper is one of the substances formed. Copper acetate, used externally, is astringent, stimulant, and escharotic according to the strength.

PNEUMONIA

A number of cases of pneumonia were observed among the foreign breeds of fowls in this College, especially among the White Leghorns, during the hot days of August and September 1922. Pneumonia is an older stage of congestion of the lungs which is "caused by chilling the surface of the body." (1) It is very probable that the affected birds got chilled by being rained on suddenly after having been exposed to the very hot sunshine, as during those months the weather was very uncertain.

The affected birds look dejected, they breathe rapidly, are indisposed to move, and show general signs of total depression. The wings droop, the plumage is ruffled, and the comb becomes dark. There is a profuse salivation, and because of this, the bird breathes with great difficulty. On postmortem examination, it was found that the tissues were dry and the skin closely adherent to the muscles. The lungs were dark in color and solid and when a piece was dropped into water it sank[4].

All of the attempts to treat the affected birds in the College were futile. As a preventive measure the flocks should be kept in good condition, and exposure prevented by providing plenty of shade for the poultry yards. Individual treatment is too laborious to be a very unprofitable undertaking.

DISEASES OF THE REPRODUCTIVE ORGANS

EGG BOUND

This trouble is very common, especially among pullets that are just beginning to lay. The bird is unable to pass the egg in the normal way from the oviduct. This difficulty may be due to the egg being too large and the passage not being sufficiently dilated as in the case of young pullets; the oviduct may be inflamed; or there may be a stricture in the passage. Some eggs, particularly pullet eggs, show streaks of blood on the shell. This indicates difficulty of passage through the last portion of the oviduct. The affected bird is restless, and she makes frequent trips to the nest attempting to lay. Later she becomes exhausted and stays in the nest. The plumage is ruffled and the bird shows all the signs of being sick. Several cases have been recorded when the bird was found dead in the nest.

Ward and Gallagher (7) recommend holding the affected fowl, vent downward, over steaming water for a time and then placing the bird in the nest. Helping the bird to lay by inserting the forefinger through the vent until the egg shell is felt, the fingers of the other hand pushing the egg to the direction of the vent guided by the inserted finger has been tried in the College but with only partial success. In cases where the oviduct is affected, either inflamed, twisted or stricted, treatment is not practicable.

BROKEN EGG IN OVIDUCT

A large number of hens have been observed to have broken eggs in the oviduct. The eggs may break either before or after the shell has been formed. The bird is restless and the feathers around the vent become moistened with the albumen from the broken egg in the oviduct. All of the cases recorded in the College were Native hens. These fowls are semi-wild and it is very probable that

[4] The autopsies were made by Dr A K Gomez of the College of Veterinary Science.

because of their being nervous, they are easily frightened and any such a disturbance is enough to break an egg in the oviduct. Some of the affected hens were saved by removing the remnants of the egg from the oviduct.

ABDOMINAL YOLK CONCRETIONS

A number of hens examined were found to contain putrifying egg yolks in the abdominal cavity. The yolks may have failed to fall into the oviduct, or they may have been aborted into the abdominal cavity by a reverse peristaltic movement of the oviduct due to some inflammatory changes in the walls of this organ. The material is partially absorbed, and the unabsorbed portion decomposes in the peritoneal cavity. This condition can hardly be noticed during the early stages of decomposition. The bird becomes weak and depressed and death due to auto-intoxication follows. In all of the cases examined, the convolutions of the intestines were cemented together by this decomposing egg yolk. Sometimes the bird so affected can be detected by the foul odor coming out of the vent, but this occurs only at the last stages of the trouble. Control, therefore, is impractical.

ABNORMAL EGGS

Abnormal eggs may be produced by fowls because of some pathological conditions of the oviduct.

Soft shelled eggs.—These may be produced because of the lack of shell materials in the diet, by feeding condiments, or they may be actually aborted, due to the fowls having been driven or frightened.

Small yolkless eggs.—Eggs like these are locally known as *ipot.* These may be produced any time. They are popularly thought to have been laid by cocks, but such a belief is entirely erroneous. When the hen is in a very active laying condition, any foreign body, no matter how small, will cause a stimulation of the oviduct, the albumen glands begin to function, and the enclosed body is passed through the different regions of the oviduct as an ordinary egg.

Double-yolked eggs.—Unusually large eggs have been sent to the College for examination, and found to contain double yolks. These have been observed to be very common also in duck eggs. This condition may be due to any one of the following: (a) Two ova dropping together into the oviduct; (b) the first yolk being delayed at any point in the oviduct: (c) the first yolk being returned by reversed peristalsis; (d) the first yolk having been dropped into the body cavity and picked up by the oviduct shortly after the ovulation of another yolk. These two yolks then pass through the different sections of the oviduct in the ordinary way.

DISEASES OF THE ALIMENTARY TRACT

DIARRHOEA

In this discussion, all troubles of the intestines causing a watery discolored discharge are included under the general term, diarrhoea. The birds are inactive, and during the early stages the combs are pale turning dark purplish-red later. The feces are very watery and vary from whitish to greenish brown or red in color. When examined, the liver and spleen are usually enlarged and the intestines are inflamed and filled with mucus.

As this disease may be caused by a bacterial infection coming from filthy conditions, cleaning the surroundings should be the first step taken in prevention.

Intestinal parasites may also cause severe diarrhoea. No attempt has been made to treat this disease in this College, but Ward and Gallagher (7) recommend the following treatment: "Where only a few birds are affected they should be given 2 teaspoonfuls of castor oil each. The entire flock may be given Epsom salts if necessary in proportion of 1/3 to 1/2 teaspoonful to each grown fowl. The salts may be mixed in a mash to be fed early in the morning. If suspicion points to the feed as the cause of diarrhoea it should be changed or fed in smaller amounts combined with other feeds." Ground charcoal is a very good intestinal corrective, and this should be so placed that it is accessible to all the birds at any time.

DROOPING ABDOMEN

A Barred Plymouth Rock hen was observed showing an unusually pendant abdomen, that almost dragged on the ground when the bird was in a standing position. This hen had not laid even one egg although she appeared to be in a very healthy condition. The skin of the abdomen was bare of feathers. The bird was sent to the Veterinary College and was operated upon. It was found that this hen had an intestinal hernia. The pendant skin was removed, care was taken to place the gizzard and intestines as nearly as possible into the normal positions, and the wound was sutured. After a few days the wound healed and the bird looked like an ordinary normal hen. As a preventive from this kind of trouble, restrict fat forming foods in the diet.

ENLARGED CROP

Several cases were observed where the birds had unusually enlarged, pendulous crops. This condition apparently did not inconvenience the individuals. Its probable cause is overfeeding at irregular intervals. Treatment is not practical unless it is a case where a valuable bird is involved, in which case it can be remedied by operation, removing a part of the enlarged crop and then sewing the two edges together.

INDIGESTION

This trouble arises from overfeeding with hard dry grain. The birds become dull and listless and are prone to sit on the roosts. Occasionally the appetite becomes ravenous. General cleanliness of the premises, feeding the birds well-balanced rations, and allowing them access to ground charcoal are recommended as preventives.

DISEASES OF THE CIRCULATORY SYSTEM

FOWL CHOLERA

Near the end of the year 1919, an epidemic of fowl cholera broke out in the College flock. Nearly all of the pure-bred birds and many of the native chickens died. The Cantonese and the Cantonese grades with the Native were the only fowls not seriously affected. Once in a while, small outbreaks of this disease are reported around the College.

The excrement of the birds affected is highly colored yellow and green, sometimes occurring together and sometimes separately. The bird isolates himself from the crowd, the feathers are roughened, and the wings droop. There is intense thirst, and generally there is a severe diarrhoea. In some cases, the bird lives several days, but in acute cases, it dies within twelve hours after infection.

Cases have been observed when an apparently healthy bird would go to roost in the evening and be found dead the following morning.

Upon examination, the heart, in almost all cases, is dotted with punctiform hemorrhages and on the liver are found whitish punctiform areas of dead tissues. The intestines contain a pasty mass which may be creamy, green or brownish-red in color.

Individual medication is not advisable, and the immediate disposal of all sick birds is recommended. Strict sanitation should be observed to prevent further ravages of the disease.

FOWL TYPHOID

Fowl typhoid and fowl cholera have many external symptoms in common, and one is often mistaken for the other. Moore (8) differentiates these two diseases as follows:

FOWL CHOLERA	*FOWL TYPHOID*
1. Duration of the disease from a few hours to several days.	1. Duration of the disease from a few hours to several days.
2. Elevation of temperature.	2. Elevation of temperature.
3. Diarrhoea.	3. Diarrhoea.
4. Intestines deeply reddened.	4. Intestines deeply reddened.
5. Intestinal contents liquid, mucopurulent, or blood-stained.	5. Intestinal contents normal.
6. Heart dotted with eccymosis.	6. Heart usually pale and dotted with grayish points, due to cell infiltration.
7. Lungs affected, hyperemic or pneumonic.	7. Lungs normal, excepting in modified cases.
8. Specific organisms appear in large numbers in the blood and organs.	8. Specific organisms comparatively few in the blood and organs.
9. Blood pale (cause not determined)	9. Blood pale, marked diminution in the number of red corpuscles.
10. Condition of leucocytes not determined.	10. Increase in the number of leucocytes.

The liver of the diseased bird is generally enlarged, and the spleen is sometimes also enlarged, dark colored and pulpy.

Prevention is the best treatment. Avoid the introduction of diseased birds on your premises, and if the disease appears in the flock, separate the diseased birds from the flock at once. Maintain sanitary condition of the surroundings.

ENLARGEMENT OF THE HEART

A White Leghorn rooster of the College flock was found dead one morning. There was no apparent cause for its death. The bird was healthy in appearance; had a good appetite; indeed there was not the slightest sign to show that the bird had been ill. When examined, the heart was found abnormally large and pale

and blood clots were found in the larger blood vessels. The other internal organs were apparently normal. The cause of this trouble is not known and as it is not generally recognized while the bird is alive, no treatment can be recommended.

DISEASES OF THE NERVOUS SYSTEM

LIMBERNECK

This condition is a symptom of several diseases. Quite a number of cases of limberneck were observed and recorded by the writer. The muscles of the neck lost control partially or completely. The bird became dull, inactive, and its feathers ruffled. The neck was twisted, turned towards the tail and could hardly be lifted. Leg weakness developed and when the bird moved, it staggered. The bird became emaciated probably because of its inability to pick up its food in the later stages of the disease. Because the head always points towards the tail, the feathers around the base of the neck upon which the head rests became wet with secretions from the mouth.

Ptomaine poisoning usually causes limberneck. In several of the cases noted in the College, the birds were badly infested with intestinal worms. Limberneck is also caused by feeding on maggots from decaying meat. Inasmuch as limberneck is a symptom accompanying several diseased conditions no treatment can be recommended. As a preventive, however, the birds should not be allowed access to decaying meat.

DISEASES OF THE SKIN

CHICKEN POX

This disease is locally known as *bulutong*. It is very contagious, and observations at the College lead to the conclusion that only chicks up to six weeks old or younger are commonly affected. No case was recorded where a mature fowl was attacked. It has been demonstrated by various investigators that chicken pox, roup, and avian diphtheria are only different stages of the same disease and all are caused by filterable virus, the nature of which is not well known. However, while no positive conclusions have yet been drawn as to the cause of chicken pox, its contagious nature is not unknown.

The disease localizes itself in the form of wartlike nodules on the unfeathered parts of the head. At first these nodules are flat, but, later, they become prominent, some individual nodules attaining the size of an average pea. Sometimes the whole head is inflamed, and very often the eyelids of the chicks attacked become swollen and become stuck together. The nodules during the later stages become covered with a red-brown crust which sloughs off in case the attack is not very serious. It was observed that recovery without treatment took place within about two weeks. In case of severe infection, the eyes may become closed and the birds die of exhaustion, not being able to see to eat.

Prevention is the best treatment. If there are only a few valuable individuals infected, these should be isolated and treated singly. The following treatment recommended by Pearl, Surface, and Curtis (1) has been followed at the College with fair results. "The crust or nodules should be removed and the place treated with creoline (2 per cent solution) or corrosive sublimate (1/1000). . . and dusted with iodoform." Tincture of iodine applied after the crust was removed and treated with creolin was also used with fair success.

The use of chicken pox vaccine is not advisable in this country for the present as the expense involved in its preparation does not warrant its use. Furthermore, as the individuals attacked are limited only to the young stock, the loss to the owner is not very heavy.

DISEASES OF THE ABDOMINAL VISCERA

TUBERCULOSIS

Avian tuberculosis is not of uncommon occurrence in this locality. This is a disease which involves not only one of the visceral organs but all of them. In the cases on the College records, a majority of the lesions were found on the liver and small intestines. The rest of the visceral organs were less affected.

Extreme emaciation is manifested in the later stages of the disease. During the early stages, the affected bird is indisposed to move about, the feathers become ruffled, the eyes bright and starry, and the appetite becomes ravenous. In many cases, diarrhoea is present, and because of this, the feathers around the vent become soiled with feces. Lameness is another symptom that may arouse suspicion. None of these, however, is specific as to the presence of the disease. On postmortem examination in ninety per cent or slightly over of the cases reported the liver of the birds affected was found to be spotted with numerous raised nodules. The intestines and the mesenteries were also found dotted with these tubercles. In a less number of cases, the spleen was greatly enlarged and contained nodules similar to those found on the liver. The kidneys, lungs, heart, and ovaries were less often involved.

The cost of preparing and administering tuberculin, a vaccine which has been found effective in testing the presence of tuberculosis in fowls by Van Es and Schalk (9), by Beach, Hastings, and Halpin (10), and by Beach (11), makes its use in this country impracticable at present. Individual treatment should not be attempted. The birds that have died or that have been killed because of the disease should be disposed of immediately, either by burning them or by burying them deep in the ground. The utensils and the premises should be thoroughly cleaned and disinfected to prevent further losses from the flock.

INTESTINAL PARASITES

TAPE-WORMS

These parasites are long, flat, white, segmented worms. They are quite common in chickens in Los Baños. The majority of the cases we have on record are young birds; the mature fowls do not seem to suffer very much from the infestation of these worms. Unless they are present in large numbers, the mature birds do not seem to mind them. The infested individuals become emaciated, although the appetite remains practically undisturbed. In bad cases of infestation, the animals become dull and sleepy and isolate themselves from the rest of the flock. The sick animals seem to develop a craving for water. The feces are thin and passed out in small amounts but at close intervals. Careful examination will reveal the presence of segments of worms in the feces of affected birds.

Rotating the grounds at least once every two or three years is one of the best preventive measures recommended against tape-worms. If the flock is already infested, the excreta should be removed daily from the houses and any parasites or their eggs which may be in it destroyed by mixing it with quicklime or saturating it with a ten per cent solution of sulphuric acid. The diseased birds, if treated

individually, should be isolated and all of their droppings either burned or treated with a solution of sulphuric acid as recommended above. Powdered areca-nut given in pills is recommended as it has been found very effective.

ROUND-WORMS

In addition to tape-worm infestation, nearly all of the chickens examined were found harboring round-worms. There were, however, few cases in which the death of the fowl could be traced directly to the presence of these worms in the intestines. These worms are long, white, and cylindrical, varying from a centimeter or less to even more than ten centimeters in length. Under ordinary conditions, the presence of round-worms does not cause any more trouble to the chicken than a slight lowering of its vitality, but in severe infestations, they cause irritation of the intestines and produce diarrhoea. Sometimes they form into rather large balls and obstruct the passage of food through the intestines. Round-worms produce symptoms similar to those of tape-worms. The comb of the affected individual becomes pale, and, in severe cases, there may be diarrhoea. The feces may be streaked with blood.

The following treatment has been found efficient in the work with the College flock, especially with chicks. Green tobacco leaves were chopped fine and soaked in water. The steep-water and the leaves were mixed with mash and fed to the birds in the afternoon. Dried tobacco leaves were also tried and produced good results. Tobacco dust mixed with the mash in the proportion of three to five parts per one hundred of mash also produced satisfactory results.

EXTERNAL PARASITES

LICE

Lice do no serious harm to adult fowls which may harbor quite a number of these parasites without showing any symptoms of illness from their presence. When the young fowls are infested, they are very much irritated, and they lose condition and become more susceptible to other diseases. The lice can be easily found either under the wing or around the vent. When a bird is badly infested, these lice will be seen crawling on the hands after handling the bird a minute or two.

The birds should be allowed access to a dust bath. The surroundings should be kept sanitary and the birds given a dry range. Ordinary commercial sodium fluoride worked into the feathers of the infested birds has been found effective in freeing them of these parasites. The following insect powder was prepared by the writer and found effective if the preparation was applied when fresh. Take three parts of gasoline and one part of creolin, mix together and to it add enough plaster of paris to take up all the moisture. Powder the bird under the wings, in the fluff around the vent and on the ventral side of the body and shake after a lapse of several minutes after the application. Greasing with lard or vaseline around the vent, on the head, and under the wings, although somewhat tedious, is also very effective for lice, especially in young chicks. Several treatments are necessary to rid the chickens of these pests.

MITES

Mites are just as common as lice among chickens in this locality. Setting hens are very much annoyed by them, and small chicks, especially the hen-hatch-

ed ones, suffer considerably from the infestation of these parasites. The young chicks lose their vitality, become emaciated, and become more susceptible to other forms of troubles.

Cleanliness, dryness, good ventilation, and plenty of sunlight are very good preventives. Pearl, *et al* (1) recommend several kinds of sprays, but these have not been tried in this College.

SCALY LEG

Scaly leg is another disease caused by mites burrowing under the scales of the legs and feet. The shank becomes very much enlarged and roughened, and, in serious cases, the bird affected may become lame. This disease used to be very common in the College flock, but it was eradicated by using the following treatment: The crusts were removed carefully after soaking the shanks in warm soap suds. After brushing off the crusts, the cleaned portions were coated with creolated vaseline. To prevent the spread of the disease, care was taken not to use infested hens for hatching. Dipping the legs in kerosene is another treatment that has proved successful.

OTHER DISEASES

BUMBLE FOOT

This trouble is not very common among chickens in this locality. It is an abscess of the foot, but the swelling may include the lower region of the shanks. This disease is not easily detected in birds, except in advanced cases when it interferes with the locomotion. Injury on the sole of the foot resulting from jumping upon hard floors, roosting on very narrow perches, or stepping on nails and other sharp-pointed objects may produce this condition.

Several cases have been successfully treated at this College by opening the abscess and removing the core and painting the wound with tincture of iodine after disinfecting it. During this treatment the birds were confined in dry quarters with soft litter on the floor.

FEATHER PULLING

This trouble is often noticed among fowls kept in a limited range. The birds pick their own and each other's feathers. A case was observed in the College flock where a Rhode Island Red hen died as a result of this vice. There were a number of other hens in the compartment, all of them being broody. One of the hens began to pick feathers from the abdomen of this Rhode Island Red hen. The other hens in the compartment also began to pick on this hen till a hole was made through the abdominal wall; when, later, the intestines protruded through this hole the hens picked on the intestine also until it was cut. As a consequence the hen died.

Feather pulling is usually due to deficiency of animal protein in the diet. Supply the deficiency in the ration and avoid a monotonous diet of a restricted number of elements. Let the birds out on a wide, grassy range. If the birds have to be confined, place them in a roomy compartment.

EGG EATING

Egg eating is a habit that is often begun through the hen eating an egg accidentally broken. It may also be the result of the same cause that induces feather pulling. Birds having this vice can be distinguished from the rest by

careful examination of their beaks. Provide the nests with plenty of nesting materials to prevent accidental breaking of eggs. Do not give the hens any more eggs than they can conveniently sit on. Keep the inside of the nests dark so that if an egg be broken the hens cannot see it. Examine the nests for any broken eggs and clean them. Hens that persist in the habit of egg eating should be killed.

NATURAL ENEMIES

One of the main causes of failure in raising chickens is the large losses due to animal enemies, such as iguanas (*bayawak*), snakes, hawks, crows, wild cats, dogs, rats, and men. Protection is the only way to keep the flock from harm from these enemies. Chickens should be housed reasonably near the residence and the yards kept clean from thick brush. The use of traps with dead chickens as bait has been found effective against iguanas and rats. Dogs sometimes develop the bad habit of chasing and killing chickens, not necessarily to eat them, but for the fun of it. Such dogs should not be turned loose in the poultry yards. Scarecrows and a shot gun will help drive the hawks and crows away from the chickens.

A POULTRYMAN'S MEDICINE CHEST

Every poultry raiser will find that the following remedies will be useful to have on hand:

Lysol; Creolin; Bichloride of Mercury; Potassium Permanganate.—These are all disinfectants, and every farmer should have one of them in his medicine cabinet. They should be used in the following strength:

Lysol.—One-half to two per cent solution in water, or about twenty drops to an ordinary beer bottle of water.

Creolin.—One-half to one per cent, or enough creolin to make the solution appear like rice-water.

Bichloride of Mercury.—One-tenth per cent, or one ordinary tablet to one beer bottle of water.

Potassium Permanganate.—One to four per cent or enough of the crystals that when dissolved in water will color the solution deep pink.

Tincture of Iodine.—To be applied on any wound. For chicken pox, apply on the raw surface left after the crust has been removed. Tincture of iodine is also used for treating early cases of diphtheria.

Iodoform.—Valuable in treating sores and ulcers. For chicken pox, it is applied on the raw surface after the crust has been removed.

Lunar Caustic.—For diphtheria, apply in pencil form on the diphtheritic areas after the false membranes have been removed.

Powdered Tobacco.—For killing round-worms. This is mixed with the mash feed.

Areca-nut Powder.—For killing both round-worms and tape-worms. Given in the form of pills.

Epsom Salts.—A purgative. It is given to birds after treating them for intestinal parasites. Epsom salts is given to birds for practically all kinds of intestinal troubles.

Castor Oil.—A purgative. Dose one to two teaspoonfuls, depending upon the age of bird. Castor oil is also useful in any kind of intestinal irritation and inflammation.

Powdered Sulphur.—Very effective in destroying mites when used in an ointment.

Sodium Fluoride.—For dusting lice-infested birds.

Vaseline; Lard.—For killing lice. Applied around the vent, under the wings, and on the head in the case of small chicks.

Bandages and Cotton.—For general use.

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CURRENT ECONOMICS OF TROPICAL PRODUCTION: II

PHILIPPINE SUGAR

For over four hundred years the one commodity among the foodstuffs of the world in point of political influence has been sugar. The cereals, legumes, and roots are insignificant as international factors due to their generality of distribution, their variety, and relatively unexacting climatic requirements. Edwin E. Slosson provides an excellent popular account of the influence of sugar power on history in *The World's Work. 45: 495-508* which every student of sugar or of economy would do well to read. He shows in his brilliant style the sugar diplomacy that ruled Europe from the fall of the Venetian monopoly in 1500 to almost the present day. Oil and rubber are but recent pets of sovereigns, envoys, and parliaments. Sugar with her record of romance and infamy may only nod askance at these two annoying *parvenus*.

It is not the province of this paper to draw an abstract of the interesting history of sugar, nor to examine the ultimates of the industry. Rather, attention is called to some immediate factors of the Philippine industry and its American market.

Philippine sugar exports.— Since early in the nineteenth century Philippine sugar (cane) has appeared in export, becoming significant in the seventies at over two million English hundred-weight. There was a gradual increase from 1875 to 1895 with no fluctuations below the two million mark. In 1895 over seven million hundred-weight was exported. Between 1895 and 1904, due largely to public disorder, exportation dropped to an inconsiderable position. By 1905 a recovery had been made and the volume from that time to this has fluctuated between two and five million hundred-weight until 1922 when the eight million point was reached.

Relative to other Philippine exports, sugar exceeded 30 per cent of all exports and held premier rank on a basis of value from 1855 to 1895. This relative importance was lost in 1896 and not regained until 1920 when the centrifugal product had replaced to a considerable extent the muscovado. In that year sugar assumed again first place among Philippine exports. Centrifugal sugar entered the export lists in 1914. Since 1920 it has constituted the bulk of all sugar exported.

With the exception of but ten years between 1855 and 1905, over 20 per cent, on a basis of value, of the Philippine sugar export has reached the United States. Not infrequently during this period the proportion exported to the United States exceeded 50 per cent and in six years exceeded 60 per cent. The relative importance of the United States market declined considerably between 1895 and 1907. From 1908 until the present the average proportion sent to the United States has been 60 per cent. In 1922 over 78 per cent in value of sugar exports went to the United States. The reason for the apparently stable United States market for Philippine sugar is two-fold: (1) favorable free entry as against foreign and Cuban sugar since 1913; and (2) the recent change from muscovado to centrifugal product limits the export of Philippine sugar to either the United States or Europe, effectively closing the Asiatic market. The first cause is un-

doubtedly the greater. Indeed, the second may well be looked upon as a result rather than a cause. By 1900 the United States began to limit its purchases to centrifugal and the shift in Philippine manufacture, muscovado to centrifugal, was a direct response—a necessary change in order to hold the United States market.

Federal protection of Philippine sugar.—Considering the facts—that very little American capital is interested in Philippine sugar production, that, on the contrary, American capital virtually controls the Cuban output, that the Cuban output is in excess of United States imports, that every pound of Philippine sugar entering the United States forces a pound of Cuban sugar to the less favorable European market—it must be apparent that free entrance of Philippine sugar while Cuba is held to a stiff duty, constitutes a deliberate and politic protection accorded the Philippines against the interest of American capitalists. The schedules of tariff follow. They apply to 96° centrifugal sugar although several lower schedules hold for 70° to 90° products.

(A) Underwood Tariff, October 31, 1913, to May 27, 1921:
  (1) $1.26 a cwt against foreign countries, except Cuba.
  (2) $1.00 a cwt. against Cuba.
  (3) Free for Philippines.
(B) Emergency Tariff, May 28, 1921, to September 22, 1922:
  (1) $2.00 a cwt. against foreign countries, except Cuba.
  (2) $1.60 a cwt. against Cuba
  (3) Free for Philippines
(C) Fordney Tariff. September 23, 1922, to date:
  (1) $2.21 a cwt. against foreign countries, except Cuba.
  (2) $1.76 a cwt against Cuba.
  (3) Free for Philippines.

The increasing monetary value to Philippine producers of free entrance to the United States market is tabulated below.

TABLE I.—*Showing United States tariff advantage to Philippine sugar producers.*

Year.	Exportation to United States 96° centrifugal cane sugar.	Tariff rate against foreign countries except Cuba.	Tariff profit to Philippine producers as compared with foreign producers.	Tariff rate against Cuba.	Tariff profit to Philippine producers as compared with Cuban producers.
	cwt.	*dollars per cwt.*	*dollars*	*dollars per cwt.*	*dollars*
1917-1918. .	1,392,111	1 26	1.754,060	1 00	1,392,111
1918-1919. .	562,396	1 26	708,619	1 00	562,396
1919-1920. .	907,016	1 26	1,142,840	1 00	907,016
1920-1921.	3,573,390	1 26	4,502,471	1.00	3,573,390
1921-1922.	5,232,231	2 00	10,464,462	1.60	8,371,569
1922-1923. . .	4,978,561	2 21	11,002,619	1 76	8,762,267
	16,645,705		29,575,071		23,568,749

Table I indicates the possible maximum and possible minimum advantage accruing to Philippine producers, through their ability to enter their commodity free of duty into the highest sugar market of the world. The maximum is arrived

at by taking advantage of the duty against foreign countries, except Cuba, which amounts to $29,575,071 for the six-year period, 1917 to 1923. The minimum is arrived at by taking advantage of the lower duty against Cuba, which amounts to $23,568,749 for the same period. The actual advantage lies between these points, probably nearer to the maximum. For conservative estimation the norm, $26,500,000, may be taken as a sure total momentary advantage enjoyed by the Philippine producers during the period 1917 to 1923.

Local subsidization.—It may be considered that the Federal protection extended to Philippine sugar would have in itself constituted sufficient encouragement to the production of centrifugal sugar in the Islands. Such, however, was not the case. Muscovado sugar had required little capital and small technical efficiency, whereas centrifugal sugar was found to necessitate heavy investment and expert management. The production of modern elaborated agricultural commodities requires in notable degree industry, ingenuity for management, and a fund of savings for investment. The Islands possessed, of these three requisites, the industry, but neither of the other two. Foreign capital was diverted in Europe by war and disorder, in America by the absorption of alien-held securities thrown on the market because of war, and by post-war industrial impetus. Entrance of foreign capital was, moreover, discouraged by strictly limited land laws enacted, be it said, by the early, American, and absolute Philippine Commission. But, although the Philippine Islands was in possession of no surplus personal wealth for the capitalization of centrifugal mills during the war and post-war years, the extremely favorable balance of trade drew heavy revenues to the Insular Government. These revenues stacked up annually to twice the average yearly budget. Much of them was expended in extension of a theretofore economical governmental machine. Still there remained an excess. The paucity of modern industries, the improbability of individual initiative undertaking them, combined with the political value of a treasury surplus led the local government into a strong and unresisted temptation toward the fantasy of government ownership. Railroading, coal, petroleum, cement, were undertaken on a national ownership basis. Incontinent loans for the building of coconut oil and sugar mills were made. These operations headed up in a National Development Company for mineral industries and a National Bank (92 per cent government owned) for agricultural and commercial loans. When, under these ambitious schemes the actual surplus was early consumed, resort was had to the entirely reprehensible act of removing the gold reserves behind the Philippine currency from safe American depositories and adding them to the capital of the National Bank.

In such manner, it became possible for Government to furnish some $20,000,000 as against the planters' $3,000,000 for the establishment of six sugar centrals. During the period 1918 to 1920 these centrals were built and largely put into operation. Government investment in them was secured by mortgages of the centrals and the planters' lands—mortgages confessedly non-collectable. To date the capital and interest have not been satisfactorily liquidated. In the financial management of the centrals, there had by 1922 been incurred deficits of $4,000,000. In 1921 the National Bank to protect its interests took over the management of the mills and organized the Philippine Sugar Centrals Agency to consolidate and economize in operations.

As to the production of sugar, the centrals today rank a success; as to financial management, they have been a complete failure and the government has until very lately lost on every unit of sugar produced. Only the planters may have profited as they have been in a position to throw the bulk of capital cost on to the Government.

The amount of local subsidization enjoyed by Philippine producers of centrifugal sugar, around $30,000,000, is about equal to a yearly budget of the Insular Government. Moreover, the amount is equivalent to more than one dollar out of six of revenues received from all sources by the Government during the years 1918 to 1922. It is doubtful if any government, other than that of the Philippine Islands, has in modern times devoted in proportion to its income so liberal an aid to any one industry, or in fact, to any group of industries.

Liquidating the "Bank" centrals.—Before the subsidized centrals had fairly begun operations, the Islands' trade balance swung to the negative and there came demand for the legitimate use of the dissipated currency reserves. The peso began a dangerous downward fluctuation. There came months when no exchange could be had, when practically the only sources of negotiable value attaching to Philippine currency were the intrinsic value of subsidiary coinage and the name of the United States of America printed on the face of the notes.

Rehabilitation, theoretically, could have been effected by selling the fixed assets of the Bank's industries including the sugar centrals. There was no use to attempt solution of the political difficulties surrounding such a procedure because there were at the time no purchasers. As an indirect policy had been employed in capitalizing the sugar and other industries, so an indirect method was followed in re-capitalizing the reserve funds. No direct appropriations from revenue were resorted to. Instead, the Philippine Islands unhesitatingly, but necessarily, increased the national debt by $51,000,000 dollars— rising from $16,000,000 in 1916 to $67,000,000 in 1923—an increase of over 400 per cent. This was accomplished by the perilously simple process of selling bonds endorsed by the United States, to citizens of the United States.

It was assumed that at least a part of the increased debt could be offset by selling or bonding the sugar centrals. Sale of centrals would necessarily have to be to the planters, to other local capitalists, or to American capitalists.

The same planters who could not pay the interest and principal of the construction loans on the centrals obviously could not purchase except on a long time amortization, which would defeat the ends of the administration—"to get the Government out of business". Very recently (September 1923) an option for the sale of Binalbagan, the largest, and potentially the best, of the "Bank" centrals, valued at $5,500,000, has been granted to a group of local capitalists which includes some of the planters whose lands are contributary to Binalbagan. The figure is for 80 per cent of the original value: the time is three years; and both the option and the installments, in case of sale, are well secured. The National Bank management is to be congratulated on this excellent stroke of business.

If, by any chance, similar disposition could be effected before the end of 1924 in the case of the remaining five "Bank" centrals, and if firm efficient authority, such as now exists, should continue in the Philippine National Bank, thus obviating any leniency in collection of payments, the losses of sugar subsidization would be largely avoided. However, as time goes by, the interest,

straight and compound, on the construction loans piles up and results in an impossible ratio between the book and replacement values of the properties. With the scarcity of local capital, reasonable sale locally of all centrals is scarcely to be expected.

Suggestion of sale to American or foreign capitalists results in a tremendous political opposition. Planters are not willing to consider themselves bankrupt, although that is the status of many of them. It is the old story of paternal loans and government ownership. It illustrates perfectly the thesis that the government in business is usually an exception to all canons of good management and commercial ethics, and that when so employed the government is wont to place itself above the very code to which it holds its private competitors. It is safe to say that if the Philippine sugar central mortgages and planters' land mortgages were held by any private bank or syndicate, foreclosure would have been impressed on centrals and lands in Philippine courts of justice over two years ago.

For a time attention was focused on a general bonding scheme to include all six of the "Bank centrals. This culminated in but one offering, the so-called Hardon scheme (August 1923) which was rejected by the planters without whose co-operation any holding company would find operation very difficult.

There are three factors in the bonding problem: the Government holding frozen credits; the debtors, sugar planters, holding influence; and the investors holding cash. In any attempt to bond, there at once appear three points for settlement: (1) valuation; (2) guaranteed interest; and (3) control.

The debtors and investors agree to bond if Government will write off or defer (which perhaps means the same thing) about one half of the book value of the credits. This reduction is requested due to the fact that construction of centrals was undertaken at peak of supply and material prices, so that buildings and machinery can, it is alleged, be replaced at one-half their book value. No responsible independent appraisal of assets has been made to date and there exists no grounds on which to figure depreciation. The Hardon bonding plan called for a practical depreciation of 50 per cent. Compared with the 80 per cent sale figure in the case of Binalbagan this seems rather too great. Replacement value is, nevertheless, the only basis of physical inventory acceptable to bondholders. Who shall stand the depreciation? The planters point to the Government. The Government has a legal right to force the entire depreciation on the planters, a moral right to share it half and half, but possibly, the political necessity of shouldering it entirely.

The second point in issuing bonds, one which seems not to have attracted much attention when it appeared as the most significant clause in the Hardon bonding plan, is that the government should be required to guarantee the interest on the bonds. There is not a great difference between government ownership and government guarantee of interest on bonds. The chief difference between the two is that in the former the government has control while in the latter bondholders obtain dominance. Government management is invariably modified by political viewpoints; control by bondholders is usually efficient, but contrives somehow to disburse income to the holding company and, however prosperous the property may be, to pass on at least a part of the interest payment to the government.

There remains the question of control. Investors, speaking the only known language of secure capitalization, demand control equivalent to investment and naturally refuse to enter on a minority basis unless provided with a voting trust. The debtor planters desire that control rest with themselves or with the Government wherein their voices bear a significant import. The planters are thus asking, in effect, bonding without effective security. It is impossible. No bonds will ever be floated on such a basis. The government might be willing to accept a 50 per cent depreciation, it might be willing to guarantee interest on bonds, but there is small chance of planters and bonders agreeing on the point of control unless the former are forced to it by stern measures. If the planters insist on their stand, they merely force the Government to give them the property outright, to accept a lengthy amortization, or to foreclose. Of these alternatives; outright gift would constitute an impossible use of government revenue; amortization would keep the Government in business indefinitely; while foreclosure and outright sale to highest bidders, not only of the centrals but also of the planters' lands which stand mortgaged to the National Bank, would let the Government out and permit the logical development of the sugar industry—but of a sugar industry which would be largely owned by American or foreign capital. The Government has generously waited two years and it is only a question of time before foreclosure will result and the planters need make haste if they care to avoid that event through bonding or local sale.

Crop loans.—The sugar planters have been raising sugar cane and manufacturing sugar for thirty years. The last ten years have been years of decidedly high-priced sellers' markets. Despite this fact, a large part of the crop is planted and harvested on loans which now amount to about $2,000,000 annually. It would not, surely, be unreasonable to suppose that after so many years, after enjoying a tariff-protected sellers' market for ten years, and after having their mills capitalized on generous terms by their Government, the planters might have some apparent wealth, sufficient at least to put in the next year's crop. However, in all too few cases has this been true. There has been a plethora of extravagance and some gambling. Many planters have yet to exhibit the fundamentals of thrift. Of industry they have a-plenty, but the success of an economic enterprise depends on three things: industry, ingenuity, and *thrift*, and of these *thrift* is the greatest.

Planters cannot afford to be looked upon as wayward nursemaids of an infant industry—they must become dependable, thrifty men of affairs if they wish to control so important a factor in Philippine prosperity. To date, the bulk of sugar crop loans has been derived from Government funds. There is a fast approaching end to the inverted cornucopia theory of government in the Philippine Islands.

The future market.—In world commodities there frequently exists a phenomenon which for want of a better term may be called "the double market". This is true of Philippine sugar. There is an *actual and fictitious market* for all Philippine centrifugal sugar in the United States due only to free entrance as against Cuba. Without free entrance and $1.76 cwt. against Cuban sugar there would be no American port receiving Philippine sugar. The *natural and ultimate market* of Philippine sugar is Europe. The conclusion is upheld by a survey of regional

production and consumption of the commodity. Such a survey is presented statistically for recent years in Table II.

TABLE II.—*Regional production and consumption of sugar (cane and beet) in short tons.*

Region.	Production 1921-22.	Production 1922-23.	Consumption 1922.	Probable consumption 1923.	Probable surplus 1923.	Probable shortage 1923.	Probable world surplus 1923.
Americas...	9,020,222	8,344,125	7,362,000	7,509,240	834,885		
Asia.......	5,900,625	6,059,250	4,893,750	4,991,625	1,067,625		
Australasia	409,500	373,500	315,000	321,300	52,200		
Europe. ...	4,541,625	5,191,875	6,801,750	6,937,785		1,745,910	
Totals.....					1,954,710	1,745,910	208,800

Table II indicates that Europe alone has a sugar deficiency. Remove the United States advantage accorded Philippine sugar and the United States would supply itself entirely from Cuba and the Caribbean littoral and leave Philippine sugar to Europe—its natural market. The significance of this condition lies in the fact that, for permanency of the local industry, the cost of production must be lowered to meet the competition in European ports with European beet sugar. If our planters continue to devote any proceeds of the free entrance returns to cost of production—if they are satisfied with an annual profit of $10,000,000—they may eventually find themselves without a market whose average price will be higher than their production cost.

The market for Philippine centrifugal sugar must normally pass through two, possibly three phases. The first phase will cover that period during which a fictitious United States market will be assured through the extension of a preferential tariff schedule to the Philippine Islands. Such a phase we are now enjoying and will continue to enjoy until one of two things occur. Should the American consumer come to believe that the duty on Cuban sugar is the cause of the high retail price of the refined product, the Cuban duty will be taken off. The American housewife wishes to buy twenty pounds of refined sugar for a dollar as she did in 1910, and considering her boycott proclivities it is not beyond the bounds of reason for her to approximate that price. It does no good to tell her that sugar at ten cents a pound is the world's cheapest edible carbohydrate. Again, should a purely locally owned production reach such proportions as to come into vital competition with the American capitalized Cuban product, there would be a strong movement to abandon free entrance of Philippine sugar. Either of these eventualities would end the present market for Philippine sugar. The chances of abandoning the free entrance favor would be decreased if any considerable amount of American capital were invested in the local industry. In the event of Philippine independence the United States is bound by treaty to allow Cuban sugar a twenty per cent preference over all foreign sugars including the Philippines.

The second phase of the marketing of Philippine sugar will be contingent upon the cessation of the first phase. It will be signaled by the necessity of discovering, competing in, and holding a European market. Successful tenancy of

such a market would depend, as mentioned, on ability to produce and lay down in European ports at a cost equal to or less than the cost of production in Europe of beet sugar. Whether the Philippine producers will be able to accomplish the movement can not be forecasted. On their present plane of efficiency they could not. Because of post-war conditions in Europe, especially the depreciation of Old World currencies, it is not profitable to attempt an analysis of present cost of European beet production.

The more remote third phase in the marketing of Philippine sugar would be dictated by the establishment of an American demand exceeding possible production in the United States, Hawaii, Cuba, the Caribbean littoral, Central America, and Northern South America. In this case, there remaining a regional deficiency in the Americas, Philippine or other Asiatic sugar would be called upon to re-enter the United States at favorable prices.

Thus it must be held in mind that on a basis of present analysis the *natural* market for Philippine and other Asiatic sugar is Europe not the United States; that the *natural* competitor with Philippine and other Asiatic sugar is European beet sugar, not Cuban cane sugar; and that for permanency of the local industry cost of production must be radically lowered.

Summary.—Philippine sugar has been in the past and is again today the first of Philippine exports It has become in bulk a centrifugal product, planted and harvested by Government loans, capitalized by Government subsidy, and marketed by virtue of Federal protection. An end of subsidy and loans is at hand, an end of Federal protection not improbable, and the necessity for clear, farsighted efficiency in production impends.

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A GENERAL SURVEY OF THE LIVE STOCK INDUSTRY IN THE PROVINCE OF ROMBLON[1]

By Miguel Manresa

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Romblon Province, located south of the island of Luzon and east of Mindoro Island, consists of four fair-sized islands and numerous smaller ones. This group of islands rises about 800 meters above sea level. The undulating hills and table lands, covered with cogon and other forage plants, well watered by springs and creeks, furnish splendid pasture for live stock. The rainfall is quite evenly distributed. Long dry seasons seldom occur. The location, topography, and climate of the province are so favorable for the raising of live stock that this industry has been carried on profitably for generations in Romblon.

Though accessible for small vessels Romblon is not on the trade routes. This partial isolation has been an effective protection to the live stock against contagious diseases.

Rinderpest was first observed on Tablas, one of the four larger islands of the province, in 1902. It is commonly believed that the infection was brought over from Masbate with salted meat. Owing to lack of knowledge of the nature of the disease, it ran the usual course spreading from place to place. The mortality was high. When it finally abated it left the island practically destitute of animals. The infection was carried to the island of Romblon, another of the larger islands, along the routes of inter-island traffic.

In 1908 rinderpest again broke out on the island of Romblon, being first noticed among swine. The former experience with the contagiousness of this disease and the severe losses which it caused during the previous outbreak stimulated the live stock owners to united efforts for its control. Although Badajoz, a municipality on the island of Tablas facing Romblon, was seriously afflicted, quarantine measures and strict prohibition of the movement of cattle, carabaos and swine, instituted and carried out by the people, who were all interested live stock owners, limited the outbreak to a few barrios.

So far as can be determined, rinderpest has never appeared on the islands of Sibuyan and Banton, two of the large islands of the province.

Stock-owners state that foot-and-mouth disease locally known as *pac-is* has been observed at various times in various places in Tablas and Romblon. Information from reliable sources show that in 1918 a disease similar to foot-and-mouth disease with symptoms of excessive drooling, severe lameness, and complete loosening of the hoofs was observed among carabaos in the barrio of Magallanes, island of Sibuyan. Thirteen animals belonging to one man were affected. All of these made very slow but complete recovery. Since then the disease has not been reported on the island.

Severe losses among swine, goats, and fowls have occurred at various times. Whether specific infectious diseases are to be charged with these losses will require systematic investigation along scientific lines.

[1] Experiment Station contribution No. 134

OWNERSHIP AND MANAGEMENT OF LIVE STOCK

Owners and managers of live stock in the province of Romblon may be divided into four groups:

1. Owners of a few animals only.
2. Partnerships, where a number of animals are furnished by a wealthy proprietor to other parties (*pa-alila*).
3. Regularly organized live stock associations (*sociedad*) in charge of administrators (*encargados*).
4. Live stock haciendas owned and managed by proprietors.

By rough estimate about 90 per cent of the stock owners belong to the first group. Small land owners that have a few animals only, select animals of a good type and give them the benefit of personal care and attention.

When the number of animals that can be properly handled by one individual has been exceeded, the excess is either sold or given to others under the partnership system known as the *alila* system. An unwritten contract dividing the offspring on the basis of fifty-fifty is entered into.

With very few exceptions the regularly organized live stock haciendas are managed through administrators (*encargados*). These administrators as a rule are not well versed in even the elementary principles of animal husbandry, so that they are not able or sufficiently interested to improve the types of animals on these haciendas. Many of these administrators do not see the stock once a year. The result is that the poorest types of animals in the province are found on these large haciendas.

Live stock farms owned and managed by their proprietors can be counted on the fingers of two hands. Animals on these farms are given better care and are therefore more docile and of far better type than those owned in partnership or association. The owners derive a great deal of their revenue from the sale of live stock, so that they have developed a system of stock raising which gives satisfactory financial returns.

ANIMAL POPULATION

Mere figures showing the number of animals in any given locality are misleading when they refer to animals of different sizes and weights. But figures do show many facts about live stock. For this reason an attempt was made to secure the latest census of animals in the province of Romblon. The figures given in Table I were reported by presidents of the different municipalities:

Municipalities	Cattle			Carabaos			Horses		
	M	F	Total	M	F	Total	M	F	Total
Badajoz	187	655	842	278	400	678	70	127	197
Cajidiocan [a]	—	—	872	—	—	1,417	—	—	527
Concepción [a]	—	—	1,173	—	—	21	—	—	25
Despujol	660	989	1,649	621	766	1,387	165	214	379
Jones (Banton)	352	1,080	1,432	378	555	933	62	107	169
Look [a]	—	—	4,014	—	—	3,823	—	—	603
Odiongan	2,138	4,274	6,412	653	1,320	1,973	195	386	581
Romblon	161	1,289	1,450	80	330	410	36	10	46
San Fernando	163	616	779	278	406	684	107	200	307
Total	—	—	18,623	—	—	11,326	—	—	2,834

[a] Figures furnished by the Director of Agriculture.

For purposes of comparison Table II is given. Data are from the Philippine Census (1918):

Number of carabaos of specified classes

Municipality.	Steers.	Bulls.	Cows.	Calves.	Totals.
Badajoz	150	225	357	179	911
Cajidiocan	357	340	612	410	1,719
Concepcion	22	32	8		62
Jones (Banton)	89	157	422	144	812
Look	597	582	1,452	754	3,385
Odiongan	1,088	645	1,786	821	4,340
Romblon	62	63	142	68	335
San Fernando	123	176	291	111	701
Grand Total	2,488	2,220	5,062	2,495	12,265

Number of cattle, horses, swine, goats, and sheep.

Municipality.	Cattle.	Horses.	Swine.	Goats.	Sheep.
Badajoz	1,842	175	1,483	870	64
Cajidiocan	1,151	182	1,432	804	43
Concepcion	721	6	851	242	9
Jones (Banton)	1,197	134	2,692	862	4
Look	3,699	338	2,763	1,257	31
Odiongan	4,153	564	2,668	1,139	55
Romblon	987	33	2,035	691	52
San Fernando	1,231	301	1,472	68	1
Totals [a]	14,981	1,733	15,396	5,933	259

[a] These figures include 4 Australian cattle, 41 Indian bulls, 86 grade mestizos, and 5 American horses, which were in the province in 1918. These animals were used for breeding purposes, but we were not able to trace their offspring or find animals of a better type resulting from this cross.

From the data given in Tables I and II it appears that there has been a decrease of 939 carabaos and an increase of 3,642 cattle and 1,101 horses. The decrease in the number of carabaos is due to the great demand for work animals in the province of Capiz which suffered heavy losses from rinderpest in 1921 and 1922.

Statistics from a bulletin issued recently by the Bureau of Commerce and Industry show that from 1916 to 1918 the number of foreign cattle slaughtered for consumption in the city of Manila was 11,390 while the native cattle slaughtered for similar purposes was 52,205, a difference of 40,815 head in favor of the local supply. This ratio is reversed in the years from 1918 to 1922 when the number of foreign cattle went up to 65,071 while the native dropped to 39,597 giving a 25,474 head against the local supply. Undoubtedly this decrease in part has

been responsible for the increase in the cattle population in the province of Romblon during the last four years.

EXPORTATION OF ANIMALS

For years the province of Romblon has been exporting all kinds of live stock, horses, carabaos, beef cattle, and even swine. The principal markets are Manila, Batangas, Capiz, Iloilo, and Negros. Beef cattle are shipped to Manila and Batangas while Capiz, Iloilo, and Negros get most of the work animals. Small shipments are carried on sailboats while large ones are made by steamer.

Since the year 1919 the demand for Romblon cattle in Manila has been very limited due to the competition offered by the Indian and Hongkong animals. The sale of work animals to Iloilo and Negros during the last few years has been likewise very limited. Negros and Iloilo hacenderos prefer the imported Indian buffaloes because they feed on dry grass and are relatively more resistant to rinderpest.

By far the greatest number of swine and poultry consumed in Romblon are obtained from the island of Banton, one of the four large islands in the province. Raising and fattening for market is well developed in that community. Tablas and Sibuyan do not export swine or poultry in great numbers, the local demand absorbing practically all that is produced.

NATURAL HELP TO LIVE STOCK

As stated previously the somewhat remote position of this group of islands protects the live stock quite effectively from epidemics and cattle plagues. Most of the pasture lands are close to the sea, making transportation of animals for export easy. Cattle egrets, sometimes spoken of as carabao birds, which feed on carabao lice and cattle ticks are numerous.

The favorable natural conditions for cattle raising should be conserved, so that an even more productive live stock industry can be developed and maintained. We can already observe that the indiscriminate destruction of wooded areas in the hills has caused the disappearance of numerous springs and creeks, unfavorably affecting good grazing grounds.

The people do not realize the immense value that the live stock industry derives from the carabao birds (*Bubulcus coromandus*, Boddaert). Many cases of indiscriminate shooting of these birds have been observed. The Philippine Constabulary is doing very creditable work in protecting, not only these birds, but all animals that are of help to agriculture; such work can not be effectively done without the co-operation of the people.

PROBLEMS FOR THE ANIMAL HUSBANDRY MAN

The most striking feature of the animals in Romblon is their small size. Old residents, to many of whom the live stock industry means so much, complain continually, stating that their animals were larger, of far better type, more desirable in every way, many years ago. Formerly carabaos exported from Romblon were large and strong, splendid work animals. Today the majority are so small, so poorly developed that it is often difficult to sell them for a good price.

A Manila cattle dealer once made the remark that Romblon cattle were as large as goats. Unfortunately this terse statement is near the truth. The animals raised on large stock farms, supervised by administrators (*encargados*) are inva-

riably of this undesirable type. They are wild, handled and loaded with difficulty and refuse food on board ship. This explains why losses from shrinkage are so great.

Horses raised on these islands, although pasture grass is very abundant, are of no better quality. They are small, pot bellied, and of bad conformation. The prevailing colors are dun, mouse-colored, and dark gray. Approximately twenty years ago Romblon horses, better known as Tablas horses, were famous for their size, strength, and endurance. Degeneration has been most marked during the last twelve years.

Lack of knowledge of the principles of elementary animal husbandry must be considered the important factor responsible for this condition. The practice of selling the largest and best animals because the owners get better prices for them has greatly aggravated this condition.

It is of the utmost economic importance that the factors causing these undesirable retrogressive changes should be known, so that proper management and breeding, upon which improvement of type depends, can be carried out. Demonstration of the beneficial results obtained by breeding to selected, desirable types of sire and dam requires many years, but the knowledge is so fundamental that efforts along such lines should be made. Introduction of new type of pedigreed animals will give quicker results. A step in the right direction would be to castrate all undesirable males as well as inferior females. With cattle the increase in value as beef animals will amply justify the expense and risk, besides removing the "scrub type" as a breeder.

VETERINARY PROBLEMS

There are no severely destructive contagious animal diseases in the province of Romblon at the present time. The last serious outbreak of rinderpest occurred in 1908. The island of Masbate, however, which is only 32 miles from Sibuyan, has been seriously afflicted with rinderpest. It must be considered infected territory so that boats, carrying merchandise and small animals to the clean islands of Romblon are a constant source of danger. This local interisland traffic must be carefully supervised and effective quarantine measures kept in force, in order to extend to the live stock industry of the province of Romblon the protection which it so well deserves.

A number of stock owners believe that foot-and-mouth disease is endemic in their islands. They state that this scourge has been observed quite frequently in different localities. In each outbreak a small number of animals only appear to have been afflicted. It is quite probable that the few outbreaks claimed to be foot-and-mouth disease were cases of poisoning caused by irritating forage plants. Circumstances did not permit substantial conclusions in regard to these sporadic, limited outbreaks.

A disease affecting young cattle and carabaos from a few weeks to a few months old and commonly known as *boyog* is at present causing the greatest loss to live stock in the province. Two haciendas were visited. On the first hacienda, in a herd of about 300 animals, it was reported that an average of about 30 calves died every year. In another herd of about 500 head, the loss was nearly 50 every year. The symptoms of this disease as described by an observant live stock owner are: depression, discharges from the mouth, nose, and eyes, diarrheoa, rapid loss of flesh, and exhaustion followed by death. The disease does not appear

to be contagious, and is most commonly observed during the dry season. It is most prevalent on the island of Tablas, less so in Romblon, and least in Sibuyan. A superficial inquiry into the causes of this condition led to the following possibilities: bad management of the herd where newly born and very young animals are allowed to mix with the old ones; severe internal and external parasitic infestations; lack of good water; and the relative scarcity of suitable feed during the dry season when the young animals are being weaned.

Poisonous plants abound in Romblon; the most notorious of these belong to the genus *Derris* locally known as *tubli*, of which there are three well-known local species. A few of the other equally notorious plants are catchubong (*Datura alba* Nees), tuba (*Jatropha curcas* L), and tigao (*Callicarpa blancoi*, Rolfe). These plants are used frequently for poisoning streams and ponds for the purpose of catching fish. Animals partaking of the water in such ponds are poisoned and many of them die with symptoms of bloody diarrheoa often mistaken for rinderpest. Some cases of malicious poisoning of streams are on record.

A few of the more progressive live stock men have begun to castrate bulls. A number of carabaos are also castrated. This is usually done by persons who, while experienced in this routine operation, entertain many queer beliefs and superstitions. The most noteworthy of these is the opinion that the removal of the epididymis (puracus or dagat-daton) weakens the animal. A great majority of the carabao owners believe this to be a fact. The greatest number of animals are castrated during August and September, soon after the rice planting season. Castrated animals are not turned to work for about six months after the operation.

It would appear that an experienced, qualified veterinarian could develop a satisfactory practice in the course of a few years. The greatest difficulty would be to demonstrate and convince the stock owners that his advice in regard to selective breeding and live stock management as well as the careful execution of routine operations are of economic value, so that they will pay for his services. It is a fact that the live stock industry is the corner-stone of all progressive agriculture, and for the protection of this industry the science of veterinary medicine is an absolute necessity. Practising veterinarians could help government bureaus to obtain reliable data on the live stock industry and outbreaks of destructive diseases among the herds of this favored group of islands.

RECOMMENDATIONS

The establishment of at least two breeding stations, one on the island of Tablas and the other on the island of Sibuyan is an immediate necessity.

As long as the scrub bulls are permitted to breed promiscuously no improvement of animals is possible. The people do not realize the harm of this practice, hence a law should be enacted making the castration of undesirable males and inferior females compulsory.

It is recommended also that a systematic investigation for the purpose of determining the definite nature of the disease known as boyod, and the reported outbreak of foot-and-mouth be carried out.

Poisoning of live stock both innocently and maliciously occurs. It is important therefore that all poisonous plants be identified so that practical ways and means of treating poisoned animals can be devised.

COLLEGE AND ALUMNI NOTES

The Philippine Society of Technical Agriculturists met at the College of Agriculture in August 26, 1923. A number of scientific papers were read in the morning meeting, and Dean Baker addressed the gathering after the banquet. A number of new members were admitted. The meeting was very well attended, and was a very pronounced success. The leaders in this organization are mostly graduates of this College. Among the visiting members were Acting Secretary Apostol, of the Department of Agriculture and Natural Resources, and Director Sanvictores of the Bureau of Non-Christian Tribes. Professor Elayda, '15, is the president of the Society and J. Q. Dacanay, '15, the secretary.

Many an alumnus of this College has been saved from embarrassment by the College of Agriculture Alumni Association through its loan fund. This fund is formed by the members depositing two per cent of their monthly salaries in the treasury of the association. These deposits draw an interest of four per cent which is distributed at the end of every calendar year. This is one of the activities of which the members of the College of Agriculture Alumni Association may feel proud.

Dr. Hamilton and family, whose home is on the Mission property adjoining the Campus on the north, are again occupying their house after an absence of more than two years, most of which time was spent in the States, with the last eight months in Manila. The Sunday services are maintained at the Student Union Church at nine o'clock in the morning, with a welcome for all. The library and reading room conducted in a room of the building is open every night for the benefit of all who wish to read books, papers and magazines. During the summer semester Mrs. Nelson found a number of choice volumes of fiction on the shelves which admirably served her purpose in teaching a course in history, books which could be obtained nowhere else locally. A new Mission residence is being constructed next to the church and when occupied Dr. Hamilton's former residence will be turned into a dormitory for students.

The Makiling Ladies' Club, a local organization composed of the wives of the members of the faculties of the Colleges of Agriculture and Veterinary Science and the School of Forestry, is one of the most active organizations in this community. It holds meetings regularly. The establishment of a local puericulture center is the present work of the Club. Mrs. M. L. Roxas is the president of the organization and Mrs. Valente Villegas is the secretary.

Saturday, July 14, 1923, was a Field Day at the College. The student body turned out *en masse* to put the athletic fields of the College in shape for the coming season. This has been the annual practice during the last ten years.

Three new cottages are being erected by the College on the Faculty Hill. With the four that were built in 1920, there will be seven of these structures on the Hill. But the number of Faculty residences will still be inadequate.

A party was given by the Ranchers' Club at the New Animal Husbandry Building in August 18, 1923, in honor of Dr. and Mrs. Gonzalez, and of Dr. and Mrs. Fronda. Dr. Gonzalez and his family recently arrived from abroad. Dr. Fronda, the adviser of the Club, who has recently joined the "Order of the Benedicts," was presented with a cane in recognition of the services he has rendered the Club.

The entire Junior Class of the High School Department of the Centro Escolar de Señoritas had an excursion to Los Baños-College on August 18.

Juan P. Torres, '19, was at the College in August to bid his professors and friends good-bye. Mr. Torres is one of the pensionados appointed from the Bureau of Agriculture, where he was employed as rice breeder stationed at Alabang. Mr. Torres expects to specialize in plant breeding in United States.

Dr. Francisco O. Santos, '19, was married to Miss Pacita de Guzman, a student in the School of Pharmacy, University of the Philippines, in July 29, 1923, at the Catholic Church in Malolos, Bulacan, the home town of the bride. A surprise party was given in honor of the couple at the Roxas' residence on August 12. Doctor Santos is at present Assistant Professor in Agricultural Chemistry of this College.

Dr. Leopoldo Clemente has been appointed instructor in entomology. Doctor Clemente is expected to arrive in the Islands from the United States about the latter part of September. He is scheduled to teach, agricultural zoology and elementary genetics. Doctor Clemente was formerly an assistant in agronomy in this College. He is a member of the class of 1917.

José Mendoza, a former student in this College, was a recent visitor in Los Baños. He has just arrived from the United States where he continued his studies after leaving the College a few years ago. He studied first in the Oregon Agricultural College where he received his B. S. degree, and he then proceeded to the University of Illinois to take some post-graduate work in Botany. He received the degree of Master of Science from that University in June, 1923.

Ramón K. Habaluyas, '19, is now Superintendent of Fabrication in the Malabon Sugar Company, at Malabon, Rizal. Mr. Habaluyas was formerly connected with this College as Assistant in Mathematics.

Simplicio Festin, '20, was married sometime ago to Miss Crispina Millares of Romblon, Romblon. Mr. Festin was formerly the Agricultural Adviser for the province of Romblon, but resigned from the service soon after his marriage to take charge of his own farm. This farm, which consists of about three hundred hectares of land—rice, coconut, and pasture land, was given to him by his father as a marriage dowry.

Messrs. Lazerna '22, Neric, '21, Ponce, '22, Padilla, '22, Acuña, '23, Olofernes, '23, Tenebro, '23, Bernardo, '21, Teruel, '23, Cagurangan, '16, Pelino, '22, and Bacomo, '16, members of the College of Agriculture Alumni Association, have been recently appointed in the different school divisions of the Bureau of Education.

D. B. Paguirigan, '16, was a visitor in the College on August 6 and 7, 1923. He is at present Assistant Agronomist in Charge of Tobacco Investigations, of the Bureau of Agriculture. The bulk of Mr. Paguirigan's work is now concentrated in Cagayan Valley. He came to the College to consult with Doctor Mendiola, '14, of the Agronomy Department about the breeding of wrapper strains of tobacco by selection and hybridization.

Francisco Bernardo, '21, has accepted a position as teacher in the Iloilo High School.

Messrs. Antenor-Cruz, Carreon, Cruz, Celis, Ferrer, Gordon, Jaojoco, Juliano, Mamaril, Nacion, Opiana, and Reyes, of the class of 1923 are back in the College taking post-graduate courses in various branches of agriculture.

The College carpenters are busy renovating the old animal husbandry bodega. This building when finished will be used temporarily to house the Los Baños branch of the Department of Military Science and Tactics.

Felix Maramba, a former student of this College, was recently appointed instructor in mathematics. Mr. Maramba is a holder of the Bachelor of Science degree from the University of Illinois, and of the Master of Science degree from the Iowa State College. He returned from abroad less than a year ago.

Enrique Lopez, '23, is located in Quingua, Bulacan, managing a one-hundred hectare farm. Like all new graduates who go out to farm, Mr. Lopez writes that he is meeting problems of all sorts and asks advice from some of his former professors in the College.

Francisco Galang, '14, was at the College in July. Mr. Galang is at present employed in the Bureau of Agriculture. He was formerly in charge of the Lamao Agricultural Experiment Station in the province of Bataan.

Domingo Casiano, a former student in the College, returned to complete the course. Mr. Casiano was to have graduated with the class of 1919, but the lures of Mindanao attracted him to accept a position as teacher in agriculture in the Provincial School of Zamboanga in 1916. After two years of successful service in that capacity, he resigned to accept another position with the Philippine National Company also in Zamboanga.

Mr. Andres Gosecco, '20, visited the College in July to buy a Nellore bull for the "Ganadería Filipina," a livestock corporation of which he is the manager.

José Dimaano, '23, is teaching biology in the High School at Romblon, Romblon.

Gonzalo Merino, '14, spent a few hours at the College during June. He is chief of Plant Pest Control in the Bureau of Agriculture.

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PHANAEROGAMIC ROOT PARASITES[1]

By D. A. Herbert

Of the Department of Plant Physiology.

Parasitism is more characteristic of the lower types of plant life than of phanaerogams, but nevertheless the number of dependent seed plants is large and the degree of parasitism exhibited by them varies enormously. Strictly speaking the term should be applied to those forms obtaining nourishment from other living plants or perhaps from plants of their own species and even from some other part of their own anatomy. In the case of the strangling figs (*Ficus* spp.), the plant sends down a long root to the ground and becomes established. In the course of time it grows to such an extent that the host plant is strangled, dies, and finally decays leaving no indications of the fig's epiphytic origin. This killing of the tree on which it germinated is commonly spoken of as parasitism but strictly speaking is nothing of the kind as the fig derives no nourishment from its living host.

In cases of undoubted parasitism definite haustoria are produced except in the extreme case of *Rafflesia* where the vegetative organs of the parasite are all internal to the host (1). In the case of the Loranthaceæ the parasitic nature of the plant is obvious, but where the haustoria are subterranean i. e., in cases of root parasitism there is generally little indication that the plant is at all dependent on other living plants for any of its food material. Some indeed show leaf reduction, e. g., *Bartsia*, which is parasitic on the roots of grasses, but this cannot be regarded as any indication as it is also exhibited by holophytes such as *Casuarina* and numerous plants growing in arid or saline habitats. The proof of the existence of root parasitism lies in the discovery of the haustoria.

One of the most important plants investigated is the Sandalwood (*Santalum album*) the cultivation of which is an important industry in India. Barber (2) and others working in India showed that it was an obligate parasite and without a host plant cannot continue to exist. Closely allied to this is the Australian Sandalwood, ***Fusanus spicatus***, R. Br. (*Santalum cygnorum*, Miq.), the wood of which is very similar to that of the Indian Sandalwood and which has now largely replaced the latter species in the Chinese market. The close chemical and taxonomic affinities of the two made it a point of interest to determine whether it too was parasitic. Investigation proved that this was the case (3).

[1] Experiment station contribution No. 192.

Further work (4) on another species of *Fusanus*, *F. acuminatus*, the Quandong, showed that it shared this characteristic with *F. spicatus* and *Santalum album*.

The haustoria on these three species are very similar. They arise laterally *from a root in contact with another root* either foreign or of the same species. The young haustorium at first consists of a parenchymatous outgrowth which rapidly enlarges forming a club-shaped organ. The cells in contact with the host have a marked power of destroying and absorbing its tissues, even the outer cork layers. The absorptive cells are rather smaller than the cells of the upper part of the cortex of the haustorium and divide rapidly pushing in and absorbing the tissues of the cork, cortex, phloem, and even some of the incompletely lignified wood elements. When the wood is reached the "sinker" as the invading tongue of tissue might be termed by analogy with the absorptive organs of *Viscum* and other Loranthaceæ, does not penetrate any further, but spreads laterally pushing aside the cortex to a certain extent as its margins grow. The cells of the upper part of the haustorium (the part external of the host root), have meantime been dividing and have produced a caplike structure. The cap acts as a protection for the sinker, but beyond this is of little use except in case of *Leptomeria preissiana* where it also serves as a place for the deposit of waste materials such as calcium oxalate.

The main points for consideration are whether the haustoria are modified roots and whether they are produced in the absence of host plants or whether they need contact of chemical stimulus before they are produced. It is not the purpose of this paper to go into a detailed account of the morphology of the parasitism of these plants, but investigation of all the available species of Santalaceæ in Western Australia (unpublished) in 1920 and 1921 and of *Olax imbricata* (5) on Mount Maquiling in 1922 showed that in no case was a haustorium produced at the end of roots. They were always produced laterally. If they had been produced terminally they might be regarded as modified root tips but their lateral origin and their peculiar structure mark them as organs as distinct from roots as the roots themselves are from stems. Cannon, however, working on *Krameria canescens* (Krameriaceæ) found that they are sometimes produced terminally. In the eight species examined, *Fusanus spicatus*, *Fusanus acuminatus*, *Exocarpus spartea*, *Exocarpus aphylla*, *Leptomeria preissiana*, and *Leptomeria spinosa* (Santalaceæ) and *Olax imbricata* (Olacaceæ), though several thousand haustoria were examined none were terminal. Numbers of them were apparently terminal owing to the fact that when their lateral haustoria become successfully attached the part of the root beyond them often dies and decays. The haustorium might then easily be mistaken for a terminal one. Examination with a hand lens however shows the scar of the decayed root.

Do phanaerogamic root parasites need contact or chemical stimulus before they produce haustoria? With some species the evidence indicates that they do, while in others that they do not. In the majority of such plants haustoria are produced only in contact with other roots, but generally the species is immaterial. *Santalum album*, *Fusanus spicatus*, *Fusanus acuminatus*, *Leptomeria preissiana*, *Exocarpus aphylla*, and *Olax imbricata*, have a wide range of hosts. The same applies to *Nuytsia floribunda* (6) the only known root parasite of the Loranthaceæ. (*Atkinsonia*, a terrestrial mistletoe found in the Blue Mountains of New South Wales has not yet been investigated). *Nuytsia* draws on ephemeral herbs for nourishment as well as on perennials.

Exocarpus spartea is a species which produces haustoria even in the absence of a host root, thus showing that a stimulus from a host plant is not necessary. In this it resembles *Loranthus philippinensis*, the most familiar of the Philippine mistletoes, which will sometimes form haustoria from its branches in the absence of a host. Very different is the case of *Leptomeria spinosa*. The parasitism of this species was investigated at Yoting, an agricultural district in Western Australia. Here there were a good many plants growing in the sand plain, and in each case they were accompanied by a low shrub, *Eremœa pilosa*. Parasitic attachments were found in each case on *Eremœa pilosa*, but no other species were attacked.

The results go to show that in the majority of cases there is no discrimination on the part of parasite, but that in some cases there is. In the latter case the chances of any particular plant of reaching maturity are small, for it may not find its host and must therefore die. Self-parasitism is common in seven of the species mentioned. It is often the simplest way of demonstrating the parasitic nature of the particular plant being investigated, as near the base of the plant the roots are fairly congested and generally some are in close contact with others. If self-parasitism takes place, as it does with most species it will be found there, and where self-parasitism takes place, parasitism on other species is always found. Investigation is needed in the case of families closely related to the Loranthaceæ and Olacaceæ to see whether it is restricted to particular families or whether it is a more or less general rule through families closely related to these two.

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THE RICE BORER (SCHŒNOBIUS INCERTELLUS WALKER)[1]

By Anastasio A. Rowan

WITH ONE PLATE

INTRODUCTION

The rice borer (*Schœnobius incertellus* Walker; Pyralidæ, Lepidoptera) is one of the worst enemies of rice in the Philippine Islands. In rice fields all over the Archipelago its attack is evident in the large number of whitened, empty panicles. Like many other serious pests, however, this particular species has been very little studied, and the farmers themselves, although undoubtedly conversant with the symptoms, generally attribute the damage to other than the actual causal agencies. In the province of Capiz, for instance, the following superstitious beliefs in regard to the appearance of the malady are current:

1. The west wind blows over the field while the rice is in flower. In the mountains between the provinces of Capiz and Antique stands a very poisonous tree that flowers during the rice season and its venom is scattered by the west wind over the rice fields below.
2. Lightning.
3. Attack of the rice bug (*Leptocorisa acuta* Thunberg).
4. Punitive acts of God or evil deeds brought about by forgotten deceased ancestors.
5. A corpse is carried past or through the rice field on its way to the cemetery.

The work of *Schœnobius incertellus* is characterized by a whitening of the entire panicle, including a large part of the contiguous distal portion of the stalk. On dissection it will be noted that the head has been severed from the rest of the plant by a *Schœnobius* larva which is lodged within the stalk. The attack of *S. incertellus* is distinguishable from that of *Leptocorisa acuta*, which it vaguely resembles, in that, in the case of the latter, there are only a few defective grains here and there in the head; there is rarely a case where the entire panicle is affected. The attacked grains, moreover, usually turn dark brown and a close examination reveals the puncture resulting from the insertion of the sucking mouth parts of the bug.

Schœnobius incertellus belongs to the family Pyralidæ. "Owing to the great difference between the male and the female, the sexes of this species have been described separately by several entomologists." Thus in 1863 the male was reported by Walker as *Chilo incertellus* and the female as *Tipanœa bipunctifera*. Later in the same year he redescribed the male of the same species as *Catagela* (?) *admotela* and the female as *Chilo gratiosellus*. Subsequently, within that year, Zeller described the male of this insect as *Schœnobius minutellus* and the female as *Schœnobius punctellus*. In 1896 Hampson described the male as *Schœnobius incertellus* and the female as *Schœnobius bipunctifer*. Shiraki, who was able to

[1] Thesis presented for graduation, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, No. 160; Experiment Station contribution No. 193. Prepared in the Department of Entomology under the direction of Assistant Professor L. B. Uichanco.

compare the Japanese and the Formosan specimens with Walker's and Zeller's types in the British Museum, was positive in his statement that *bipunctifer* is the female of *incertellus.*

REVIEW OF PAST WORK

Except for a few scattered references in the literature, no published account about this pest has appeared in the Philippines up to the present time. These few references are included in general reports and in various special papers on other subjects pertaining to rice. Among the earlier authors who casually noted the damage done by this pest in the Philippines were Mackie (2), Gutierrez (3), Romero (4) and Camus (5).

In other countries, this pest has been more thoroughly studied. Leading the others in this respect is Formosa where Shiraki (1) has quite recently published a very creditable piece of work embodying an intensive series of investigations on *Schœnobius incertellus* for a period covering about six years.

The pest has also been studied, though on a less extensive scale, in Federated Malay States by Pratt (6), in Calcutta by Mackenna (7), in Assam by McSwiney (8), in Cochin China by Vincens (9), in Madras by Wood (10), in the Dutch East Indies by Hall (11), and in India, Burma, and Ceylon by Fletcher (12).

MATERIALS AND METHODS

Artificial breeding work in the laboratory was conducted by confining moths in cages, a pair consisting of a male and a female in each cage. Breeding cages were made of cheese cloth with bamboo frames for support. These were set upon a kerosene can in which rice plants were transplanted. Access to the insects under observation was through a door on one side of the cage.

Only individuals which emerged from the pupæ in confinement were used in the present investigations. In order to supply material for this purpose, larvæ were brought from the field into the laboratory and there reared under controlled conditions.

Field observations were also made in order to determine the time and place of oviposition under natural conditions, and also the habits of the insect in its various stages. The extent of damage was also studied in the fields both of the College of Agriculture and of private planters in the neighboring districts.

RESULTS

MANNER OF OVIPOSITION

Observations based on five moths seem to indicate that the eggs are laid from one to three days after the emergence of the adults. Oviposition was found to take place in the earlier part of the evening. The female which is about to lay eggs crawls on to the upper surface of the leaf at a distance of about twelve centimeters from the tip. While her head is directed toward the tip she exudes a sticky dark-red fluid from the anus. This process is followed by the eggs which are fastened on the leaf by means of that substance. The eggs are probably held together in a mass by a yellowish fluid, also exuded by the mother between ovipositions. When all the eggs are laid, the mass is covered with hair from the anal tufts of the moth. This is done by dragging the abdominal cauda across

the mass, and with the help of the hind legs the hair tufts are set loose. After oviposition the moth either crawls further forward to the tip or flies to the neighboring plants.

TABLE I.—*Egg masses: Number of eggs in each mass, position, and size.*

Mass number.	Position on leaf.	Distance from tip.	Size of mass.		Number of eggs in mass.
			Length.	Width.	
		cm.	*mm.*	*mm.*	
1	upper	7.8	5.5	3.5	42
2	upper	7.2	5.5	3.5	38
3	upper	9.5	7.0	4.0	54
4	upper	11.6	7.5	4.5	60
5	nether	40.7	8.0	4.0	74
6	upper	5.6	7.0	4.0	58
7	upper	14.3	7.0	3.5	68
8	upper	8.1	8.5	4.5	96
9	upper	12.1	6.0	2.5	48
10	upper	6.2	6.5	4.0	54
11	upper	35.8	7.0	3.0	62
12	upper	7.0	8.0	4.0	72
13	upper	2.5	5.0	3.5	43
14	upper	12.3	7.5	4.0	72
15	upper	7.7	6.0	3.5	68
16	upper	11.6	7.5	3.5	68
17	upper	8.4	8.0	4.5	84
18	upper	7.4	7.5	3.5	68
19	upper	14.7	5.5	3.5	59
Minimum . . .		2.5	5.0	2.5	38
Maximum. . . .		40.7	8.5	4.5	96
Average. . .		12.2	6.8	3.7	62.5

With the exception of Egg No. 5, which was laid on the nether surface of the leaf, it will be seen in Table I that the eggs are laid on the upper surface from 25 millimeters to 407 millimeters from the tip, the average being 122 millimeters. The egg masses measure from 5 millimeters to 8.5 millimeters long, the average being 6.8 millimeters, and from 2.5 millimeters to 4.5 millimeters wide, the average being 3.7 millimeters. The number of eggs present in each mass is from 36 to 96, the average being 62.5. As shown in Table II, the length of incubation period ranges from 8 to 9 days.

LARVÆ

Habits.—On hatching, the young larvæ bore holes through the leaf upon which the egg mass is attached. They move on the surface of the leaf at the rate of five to seven centimeters a minute, biting here and there as they proceed until they find a convenient place on which to settle. Sometimes they suspend themselves on a fine silken thread which they spin from their mouths and allow themselves to be carried away by the wind in this position and be landed on another plant. Upon finding a suitable host, the larvæ bore their way through the leaf sheath and finally inside the young stalks. The entrance into the stalk made by the newly hatched larvæ is so small that it is quite inconspicuous. Larvæ which happen to settle on an old, or otherwise hard, stalk usually crawl in between the latter and the leaf sheath and eat off the young lateral shoot, in this manner forming holes large enough for their admittance into the interior. As many as twelve young larvæ may be found feeding within a single stalk, but of the more fully grown individuals there is usually only one present. They are very vora-

cious feeders, soon severing the more distal from the lower portion of the stalk and causing the former to dry up. The insect then migrates into the next lower internode by eating its way through the intervening node. After using up the available food in the original host, the larvæ migrate to another, and the process is continued until pupation. In the present observation, a larva has been seen to use three culms in succession, which in this case happened to belong to three different plants, before reaching the pupal stage.

Description.—The full grown larva usually measures from 20 to 25 millimeters long and from 3 to 3.5 millimeters in diameter. The head and the first segment of the thorax are dark brown, approaching black. The body is creamy white with one light brown dorsomesal and four subregular lateral lines. The body is sparsely covered with moderately long hairs, which grow more thickly at the head and at the abdominal cauda. Moreover, the cephalic and the caudal hairs are longer than those on the rest of the body.

One or two days before molting, the larva ceases feeding. Its color becomes darker and it seldom moves. About twelve hours after molting, feeding is resumed, and the larva eats voraciously during the day as well as during the night. This condition continues until one or two days preceding each subsequent molt when the insect becomes inactive again.

PUPATION

The larva which is about to pupate moves into a lower internode of the rice plant at a distance of from ten to fifteen centimeters, and occasionally thirty centimeters, or higher, above the surface of the ground. A hole is made through the wall on one side of the stalk large enough to allow the adult moth to pass out when it emerges. Silk thread is woven across the hollow of the stalk just above this opening and the latter is then closed with the same material. The larva subsequently moves down to a distance of about two centimeters below the emergence hole, and with the head directed upward it covers itself with a thin cocoon, and the body contracts. A day or two later the larval skin splits dorsomesally from the cephalic region. The young pupa casts off the last larval skin by means of a continuous dorsoventral rocking motion of the body.

The pupa is creamy white at first, but gradually turns brown and then finally red. It usually measures from 9 to 13 millimeters long and from 3 to 4 millimeters in diameter. The head is blunt and the abdomen tapering. During the pupal stage the insect is inactive, moving only when disturbed.

ADULT

The moth emerges from nine to eleven days after pupation. The pupal skin splits along the anterior dorsomedian line and the young moth pushes the old skin back by means of its legs. Then it crawls up and breaks through the silk enclosure across the emergence hole. After the moth escapes it seems to be strong and active, and can run about rapidly on being disturbed. The wings which are folded close to the body expand and dry after a few minutes. About two hours later the wings are ready for flight. If for any reason the wings dry up before they are fully expanded or before the moth has escaped from its imprisoning internode, the insect becomes crippled and remains in this condition for life.

The moth is easily recognized by its yellowish white color and the presence of a black dot at the lower angle of the distal cell of each forewing. The female

usually measures from 9 to 12 millimeters long and the expanse of the wings is from 24 to 28 millimeters; the male is from 8 to 10 millimeters long and the expanse of the wings is from 18 to 23 millimeters. Hampson (13) describes the male as follows:

> Brownish ochreous. Fore wing irrorated with dark scales and the veins slightly streaked with fuscous; a black spot at lower angle of cell; an oblique fuscous line from the apex to vein 2; a marginal series of black specks. Hind wings ochreous white.

Of the female, he writes:

> Head, thorax and abdomen yellowish white. Fore wing suffused with orange-yellow; a black spot at lower angle of cell. Hind wing white, often tinged with yellow towards outer margin.

During the day the moths hide under the thick leaves of the rice plant or among the grass that grows around the field. If they are disturbed they fly about, aimlessly, apparently, before they again seek cover. When disturbed a second time their flight is faster and usually farther than before, and on lighting they crawl rapidly under the thick, dry leaves so that they are often lost sight of until they fly again. Strong rain or wind does not cause their flight. On the contrary they cling fast to the leaves, or else crawl to the nearest thick growth for shelter. If disturbed at this time they seldom take to their wings.

They begin to become active at sundown, when they are often seen flying out of their hiding places. The direction of their flight is toward the center of the rice field and they alight on the upper surface of the leaf, about midway from the tip. Oviposition mostly takes place during this time.

No close observation was made on the moths during the night, but probably this is the time in which they are most active. While working in the College Library during the nights of the school year 1921-1922, these insects were often seen hovering about the electric lights. Shiraki (1, page 188) on the basis of his observations in Formosa and in Japan, reports that this moth is attracted to light more than other species of night-flying moths.

The activities of the moths begin to lessen at dawn. Their flights at this time are long and are directed toward the dikes or toward the thick grass near the borders of the field. After sunrise the insects are seldom seen on the wing. In fact they appear lethargic, as several specimens showed when these were carried on a leaf in day time from the rice field to the insectary, a distance of about five hundred meters. The insects in this instance did not fly away although the leaves were shaken at times.

LIFE HISTORY

Newly laid eggs were collected from the field, brought into the laboratory and transferred into test tubes, each mass being confined separately and labelled. The mouth of the test tube was plugged with cotton. After four days portions of young stalks of rice were introduced into the test tube to feed such larvæ as might be hatched by that time. The feed was renewed daily thereafter. On hatching, each larva was confined in a separate tube to facilitate making more accurate records. On pupation each pupa was transferred to a separate jelly glass. Adults were kept in confinement in battery jars.

The larva molts seven times, the seventh marking its transition to the pupal stage. As shown in Table II, the duration of the first instar is from 6 days to 9 days, the average being $6\frac{23}{24}$ days; second, from 7 days to 9 days, the average being $8\frac{1}{6}$ days; third, from 7 days to 9 days, the average being $8\frac{1}{24}$ days; fourth, from 8 days to 11 days, the average being $9\frac{7}{24}$ days; fifth, from 8 days to 11 days, the average being $9\frac{5}{24}$ days; sixth, from 10 days to 13 days, the average being $10\frac{7}{8}$ days; and the seventh, from 9 days to 13 days, the average being $10\frac{7}{8}$ days. The pupal stage is from 9 days to 12 days, the average being $10^5/_6$ days. The moths live from 3 days to 7 days, the average being $4\frac{1}{2}$ days. The total length of the immature life of the insect after laying is from 80 days to 85 days, the average being $82\frac{17}{24}$ days. The insect remains in the larval stage from 60 days to 66 days, the average being $63\frac{5}{12}$ days. (Table II)

SEASONAL OCCURRENCE AND ABUNDANCE

This insect is apparently present in all stages of growth throughout the year, except during the dry months of March, April, May, and the early part of June, when they undergo a period of æstivation as larvæ and pupæ in rice stubble where they are lodged at about the level of the surface of ground. It should be remarked, however, that this observation did not cover irrigated paddies. Occasionally, larvæ in semidormant condition were noted, particularly in deserted *caiñgins*[2] during this period. In July the adults begin to emerge and their sexual activities are evident from the number of egg-masses noticeable in the fields at this time. This condition of affairs continues until February. Egg-masses are found most abundant during September and October, and during January and the earlier part of February. The least number of egg-masses, outside of the period of æstivation mentioned above, is observed during the months of July, August, November, and December.

From the foregoing observation we are led to infer that the period of the insect's greatest activities, when it is capable of doing a large amount of damage is during the months of September and October and during January and the earlier part of February. These months represent the times of the year when the Philippine rice fields are covered with young and tender rice plants, into the stalks of which the *Schœnobius* larvæ can easily gain access.

NATURAL ENEMIES

Enemies of the eggs.—During certain seasons of the year eggs are heavily parasitized by certain hymenopterous parasites which lay their eggs on the egg-mass of the moth. On hatching, the parasite larvæ eat their way into the interior of the host's eggs. The adult parasites are very commonly observed on the rice paddies and are probably the most important natural check of *Schœnobius incertellus*. Shiraki (1, pp. 50-71) reported that the three most important parasites on the eggs in Japan and Formosa are *Trichogramma japonicum* Ashm., *Ceraphron beneficens* Zehnt. and *Tetrastichus* sp.

Enemies of the larvæ.—During migration from one plant to another many of the larvæ perish on the way, either because of their inability to settle in a new host or from the attack of predaceous or parasitic enemies. Three species of

[2] A cleared piece of land on which rice, corn or vegetables are planted in a primitive manner.

parasitic Hymenoptera were reared in the present investigations; these have been sent abroad for identification. Certain species of ants are also important enemies of the pest during this period. Among the other predators observed are the praying mantis, spiders, frogs, centipedes, and birds. The extent of destruction of the larvæ by birds is not great due to the habit of the former of migrating during the evening. Centipedes are perhaps the most efficient predators on the pest at this stage, as they were the insects most commonly found eating the larvæ during the present observations. A smaller species of centipede follows the larvæ through their holes into the hollow of the stalk and attacks them there. A considerable percentage of the larvæ have also been found to die from the attack of a fungus disease.

Enemies of adult.—The habit of the moth of flying at night renders the adult insect quite safe from the attack of birds, dragon flies, and other diurnal predators. Some of the important enemies at this stage which were observed in the present investigations are certain species of spiders which attack them in their hiding places: frogs; *dalag* (*Ophiocephalus striatus* Bloch), which attacks them whenever they rest on a blade of grass near the surface of the water; and mantids.

EFFECT OF INFESTATION ON PRODUCTION

On account of the absence of sufficient reliable data, no definite conclusions have so far been drawn in regard to the extent of damage caused by *Schœnobius incertellus.* With the end in view of contributing information on this important phase of the subject determination of infestation on twelve varieties of rice grown in the different parts of the College Farm during the year 1922 were made. The results are included in Table IV, a summary of which is given in Table III.

TABLE III.—*Extent of infestation on different rice varieties.*

Number.	Name of variety.	Percentage of infestation.
		per cent
1	Makabiag	2 0
2	Daluson	6 9
3	Murmuray	5 6
4	Masinag	0.8
5	Lumbang	8 8
6	Iroy	5 7
7	Pinili	5 2
8	Kinastila	3 2
9	Guininto	32 2
10	Kinagaykay	23 9
11	Kuliit	20.4
12	Inarañgilan	17 3

The first eight varieties were planted to the west of the Administration Building of the College of Agriculture. The surroundings were clean. The last four varieties were planted side by side by two tenants of the College on the Experi-

ment Station grounds. The field was surrounded with tall bushes, talahib (*Saccharum spontaneum* L. subsp. *indicum* Hack.) and other grasses. As shown in Table IV, the damage on these four varieties varied from 17.3 per cent to 32.2 per cent.

Determination was also made on variety Iroy, in December, 1921, and it was found that out of 2621 plants in 7 rows, 744 were damaged, representing a loss of 28.4 per cent.

Supplementary to the foregoing investigations, various *caiñgins* on the slopes of Mount Maquiling were inspected during the months of September and October, 1922, and the damage was found to be not less than 5 per cent on the average. Several visits were also made to different rice fields in the municipalities of Los Baños and Bay, Laguna Province, during the months of January and February, 1923. An approximate estimate of *Schœnobius* damage in these fields would place the figure at between 5 and 10 per cent.

SUSCEPTIBILITY OF DIFFERENT RICE VARIETIES

During the month of June, 1923, eight varieties of rice were planted in the irrigated plots lying side by side behind the Administration Building of the College of Agriculture. The extent of damage on each variety was determined as follows: Three small squares, each measuring one square meter, were marked in each lot; the first square was on that part of the lot where the growth of rice plants was thinnest; the second was on a moderately crowded part of the lot; and the third, where growth was thickest. All the heads inclosed within these respective squares were then counted. The total area of the lot was taken. The product resulting from the total number of heads in the three squares, divided by three and multiplied by the total area of the lot was taken as representing the approximate number of heads in the entire lot.

The total number of heads destroyed in the lot was determined as follows: As soon as signs of attack were observed the white heads were collected, leaving the stalks intact, so that what larvæ they might enclose would be left undisturbed. The white heads collected were then counted. This process was carried out at regular intervals, on Tuesdays, Thursdays, and Saturdays, until the rice was harvested. The numbers of damaged heads collected at different times were added and their sum divided by the total number of heads in the lot, then multiplied by 100. The result is the approximate percentage of heads destroyed in the lot.

The results of the foregoing experiments are given in Table IV.

TABLE IV.—*Relative extent of damage on twelve varieties of rice in the College of Agriculture.*

Variety name.	College number.	Origin of variety.	Place of observation.	Area observed.	Total number of plants in the field.	Total number damaged.	Percentage of damage.
				sq. m.			*per cent*
Makabiag...	17564	Batac, Ilocos Norte...	West of Main Building.	15.6	2325	48	2.0
Daluson.....	17565	Batac, Ilocos Norte..	West of Main Building..	20.0	5000	345	6.9
Murmuray...	17567	Batac, Ilocos Norte...	West of Main Building..	22.0	3850	214	5.6
Kinastila....	17565	Batac, Ilocos Norte...	West of Main Building..	21.5	3843	123	3.2
Masinag.....	7365	Central Luzon Agricultural School........	West of Main Building..	23.5	2843	22	0 8
Lumbang....	10872	Unknown...	West of Main Building..	21.0	3675	323	8.8
Iroy	5894	Rosales, Pangasinan .	West of Main Building..	25.0	4375	248	5.7
Pinili........	8196	Morong, Rizal......	West of Main Building. .	21.0	2625	137	5.2
Guininto ..	None	Unknown..	Experiment Station.	4.0	905	291	32.3
Kinagaykay	None	Unknown......... ..	Experiment Station. ..	4.0	821	196	23.9
Kuliit.......	None	Unknown........ ..	Experiment Station.	4.0	784	160	20.4
Inarañgilan..	None	Unknown...........	Experiment Station...	4.0	400	69	17.3

It will be seen from Table IV that varying degrees of susceptibility are exhibited by different rice varieties. Variety Masinag, with only 0.8 per cent infestation, appeared to be the least susceptible, while Lumbang with 8.8 per cent, represented the greatest amount of damage. Although the former variety shows advantage in that respect, yet it can not be recommended for planting on a large scale, on account of its low stooling quality and the consequent poor yield.

EFFECTS OF SPACING

It was suspected that crowding of the rice plants had something to do with the severity of infestation. Three varieties were planted in the rice field behind the Auditorium of the College of Agriculture in June, 1922. Each variety was planted in five separate lots, lying close to each other. The treatment given to each of the five lots was as follows:

Lot I, distance between plants, 10 cm.

Lot II, distance between plants, 15 cm.

Lot III, distance between plants, 20 cm.

Lot IV, distance between plants, 25 cm.

Lot V, distance between plants, 30 cm.

The percentage of damage in each lot was obtained in the manner described in the preceding discussion. The results are embodied in Table V.

TABLE V.—*Effects of spacing on degree of infestation.*

Variety name.	Plot No.	Area observed.	Distance between hills.	Number of plants per sq. m.	Approximate number of plants in the lot.	Total number of plants damaged.	Percentage of damage.
		sq. m.	*cm.*				*per cent*
Makabiag..	I	17.0	10	154	2618	96	3.7
	II	15.0	15	133	1995	85	4.3
	III	14.5	20	123	1783	82	4.6
	IV	15.0	25	101	1515	24	1.7
	V	18.6	30	125	2325	48	2.1
Kinastila...	I	23.7	10	155	3674	106	2.9
	II	23.2	15	180	4176	148	3.5
	III	21.5	20	175	3763	123	3.3
	IV	23.7	25	145	3437	133	3.9
	V	23.2	30	189	4385	216	4.9
Iroy.......	I	12.2	10	275	3306	168	5.1
	II	12.0	15	224	2688	187	6.9
	III	11.4	20	204	2326	129	5.5
	IV	11.5	25	165	1898	109	5.7
	V	15.6	30	172	2683	138	5.1

An examination of Table V tends to show that distance is not a factor in the degree of infestation by *Schœnobius*. One possible contrary evidence against this conclusion is furnished by variety Makabiag, where among plants set at 101 to a square meter, the extent of damage is only 1.7 per cent, as compared with 4.6 per cent in the more crowded areas.

SUMMARY AND CONCLUSIONS

1. *Schœnobius incertellus* is one of the worst pests of rice in the Philippine Islands. The insect belongs to the family Pyralidæ, order Lepidoptera.

2. The Filipino farmers notice the symptoms of attack but are in general unacquainted with the borer itself.

3. The work of the rice borer is characterized by a total whitening of the entire panicle, including a large part of the contiguous more distal portion of the stalk.

4. Rice borer is reported to be a pest in almost all rice-growing regions in the Orient, notably in Formosa, Japan, India, the Dutch East Indies, French Indo-China, Federated Malay States, and Ceylon.

5. The moth lays its eggs in a mass on the upper surface of the rice leaf, at a distance of about 12 centimeters from the tip.

6. The number of eggs present in each mass varies from 36 to 96.

7. The newly hatched larvæ bore into the stalk and eat up the tender part thus severing the more distal from the lower portion of the plant and inhibiting the formation of grains.

8. As many as 12 young larvæ may be found feeding in one stalk, although there is usually one to each stalk in the case of more fully grown larvæ.

9. The larvæ migrate to another plant after the food in the host is consumed.

10. The larva ceases feeding one or two days before each molt. Feeding is resumed generally 12 hours after the process.

11. Pupation takes place at the lower part of the stalk, at a distance of from ten to fifteen, and occasionally thirty, centimeters, or higher, above the surface of the ground.

12. The moths are active at night, beginning at sundown and ending at sunrise. The adult insects are attracted to light. It is interesting to note that most of the individuals collected by lamplight in the present work were females.

13. During the day the insects hide among the grass or among the thick growth of rice.

14. The life history varies from 84 to 90 days. The period of incubation varies from 8 to 9 days; the larval stage, from 60 to 66 days; the pupal, from 9 to 12 days; and the adult from 3 to 7 days. The total length of the immature stage varies from 80 to 85 days.

15. The insect apparently passes a period of æstivation in rice stubbles in the form of larvæ and pupæ during the months of March, April, May, and the early part of June, and becomes abundant during the months of September and October, January and the earlier part of February.

16. The eggs are parasitized by certain ichneumonid and chalcid parasites which lay their eggs on the egg-mass of the moth.

17. Among the predators of the larvæ are certain species of ants, praying mantis, spiders, frogs, centipedes, and birds. A considerable percentage of the larvæ has been found to die from the attack of a certain fungous disease.

18. The adults are attacked by birds, certain species of spiders, frogs, mantids and *dalag* (*Ophiocephalus striatus* Bloch.)

19. The damage on rice in the College of Agriculture during the year 1922 varied from 0.8 per cent to 32.3 per cent. Different varieties of rice show different degree of susceptibility to the attack of the pest

20. Fields with grassy surroundings and with stubble left after harvest appear to be more susceptible to the heavy attack of *Schœnobius* than the cleaner ones.

21. Spacing has practically no effect on the degree of infestation.

RECOMMENDATIONS

Clean culture of the fields is strongly recommended. Grasses which may serve as alternate host plants and rice stubble wherein the insect may tide over periods between rice plantings should be removed after harvest. Submergence of the stalks in irrigated fields with the idea of killing their inclosed larvæ may also be tried. A more thorough study of their parasitic and predaceous enemies and also of the more important resistant rice varieties will help greatly in the solution of the problem of controlling this pest. Collecting of egg-masses would lessen severity of attack.

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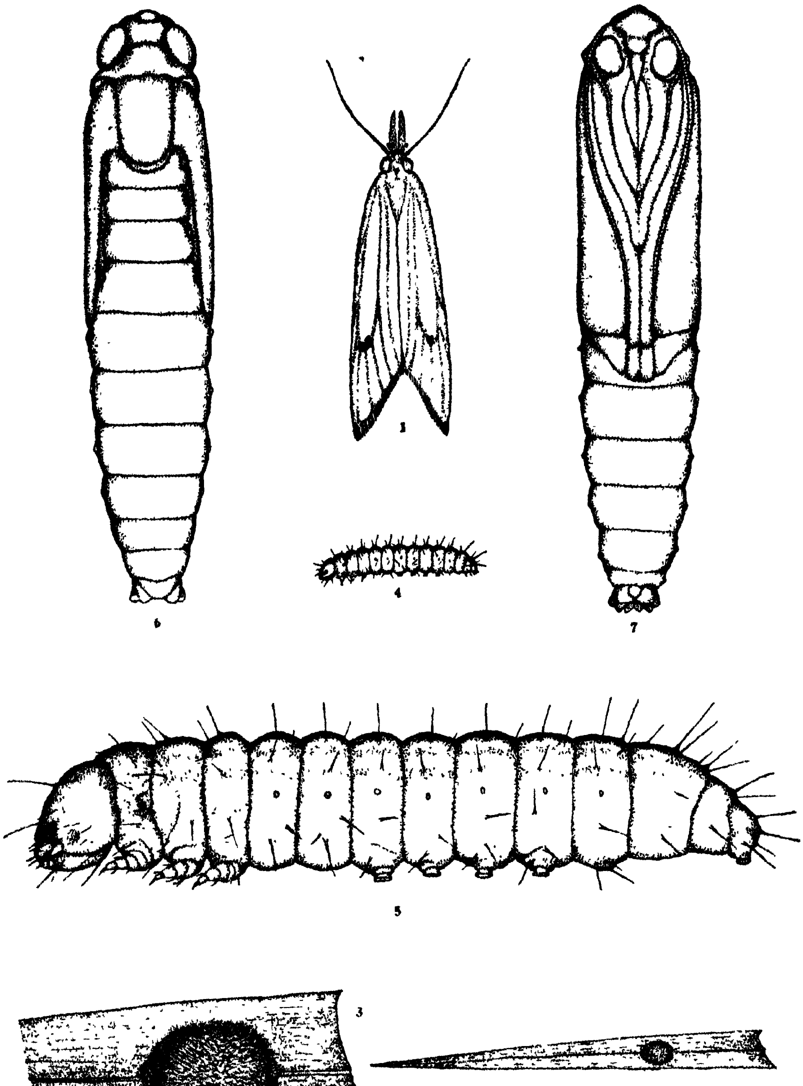

PLATE I

Fig. 1. Adult moth, female, dorsal view. $\times 2\frac{2}{3}$.
2. Egg mass, showing normal position on leaf. $\times \frac{2}{3}$.
3. Egg mass, enlarged. $\times 2\frac{2}{3}$.
4. Larva, first instar, lateral view. $\times 6\frac{2}{3}$.
5. Larva, full grown. $\times 6\frac{2}{3}$.
6. Pupa, dorsal view. $\times 6\frac{2}{3}$.
7. Pupa, ventral view. $\times 6\frac{2}{3}$.

A STUDY OF THE EFFECTS OF SNAILS AS A SUPPLEMENT TO A RATION FOR LAYING HENS[1]

By Generoso RullODA Frigillana

INTRODUCTION

Feeding the laying hen properly is one of the most important problems in poultry raising, for feeds and feeding have a direct relation to egg production. According to Philips (1) the hen manufactures eggs from the feed that is given her and the number that she can produce depends a great deal upon the nature of the ration.

There seems to be a difference of opinion among writers on poultry on the question of feeding laying hens. Thompson (2) in his report about the system of feeding from a ten-year egg-laying test which was performed at Hawkesbury Agricultural College and Experiment Farm, Richmond, New South Wales, advocated "full and heavy feeding." He said, however, "Great authorities, among them Lewis Wright, have said 'feed slightly.'" He mentioned further that leading Australian authorities and many foremost American writers have said the same thing. From this it can be seen that the methods advocated are the two extremes, and it is hard for the poultry raiser to choose.

Buss (3) commenting on the subject of feeding laying hens said, "All rations for laying hens should contain a liberal amount of high protein feed secured from an animal rather than from a vegetable source." Philips (4) in results of a four-year experiment showed that the average egg production per hen per year of fowls fed with a ration containing meat feed was 132.8 eggs, while those which did not receive any meat feed averaged only 32.5 eggs. Under Philippine conditions, Fronda (5) of this College reported that egg production from snail-fed hens was higher than that of his copra meal-fed hens. Goseco (6) of the same College also reported that the egg production of his snail-fed ducks was higher than that of his copra meal-fed ducks.

The study here reported is on the effects of ground corn, rice bran, and snails as supplements to a basal ration consisting of palay (unhulled rice) and whole corn for laying hens. The objects were: (1) To find out the effect of snail (crushed and cooked) upon laying hens; (2) to find out which is more efficient and more economical for egg production: a supplement consisting of ground corn, rice bran, and snails or one consisting of ground corn and rice bran.

Snail was used in this study as a part of the supplement for the hens of one lot to further place under trial the results and conclusions deduced by Fronda (5) and Goseco (6).

The study was carried out in the Department of Animal Husbandry, College of Agriculture, Los Baños. It covered a period of seven months from July 6, 1921, to February 6, 1922.

[1] Thesis presented for graduation from the College of Agriculture No. 161, Experiment Station contribution No. 194. Prepared in the Department of Animal Husbandry under the direction of Mr M Mondoñedo.

MATERIALS AND METHODS

MATERIALS USED

Twenty laying Cantonese hens and two Cantonese roosters were used. All these birds were healthy and vigorous. On all the hens, except two, there was a one-year record on egg production.

The ration for each lot was divided into two parts; namely, the basal part and the supplemental part of the ration. The basal portion consisted of shelled corn and unhulled rice and the supplemental portion consisted of ground corn, rice bran, and snail (crushed and cooked). In addition to these feeds, grits, ground charcoal, and fresh water were also supplied.

PLAN OF THE EXPERIMENT

Arrangement of the birds.—The flock was divided into two lots, designated as Lot A and Lot B. Each lot had ten hens and one rooster. In the division of the flock care was taken to secure uniformity in weight, size, and vigor for each lot. Every bird in each lot had a tag number for identification.

Housing and yarding.—One of the poultry houses of the Animal Husbandry Department was used. This house is three and one-half meters wide and seven meters long. It has two compartments, each of which was provided with eight good trap nests, four permanent coops for confining and breaking broody hens, a self-feeder with three compartments, wooden dropping boards one and one-half meters wide and about three and one-half meters long, and three rows of scantlings 45 centimeters apart running lengthwise, for roosts. Adjacent to each compartment was a yard wire fenced, 30 meters by 12 meters, which was divided into two parts so as to allow rotation of pasture. This arrangement of the grass range of each lot gave the birds a chance to have fresh pasture throughout the course of the study. The land in which the poultry house and the grass range are located is well drained and well ventilated.

System of feeding.—Both lots were given a basal ration which consisted of whole corn and unhulled rice in the proportion of one to one by weight. This was supplied to the birds twice a day, at nine o'clock in the morning and at four o'clock in the afternoon.

Feeding was adjusted until an amount which they readily ate was reached. The amount of basal feed given each time after the first week of the experiment was 0.2 kilogram in the morning and 0.3 kilogram in the afternoon for each lot consisting of eleven birds. The object of giving more of the basal feed in the afternoon than in the morning was to have a few grains left on the ground for the birds to pick up early the next morning when they were just off from the roosts.

The supplement for Lot A consisted of ground corn, rice bran, and snail (crushed and cooked); for Lot B it consisted of ground corn and rice bran alone. The ground corn and rice bran were in the dry form and were given separate to the hens by means of self-feeders (one self-feeder for each lot). The snails which were crushed and cooked were given to Lot A in a trough. All of these supplements were placed so as to be accessible to the fowls all the time. This method gave every bird of each lot a chance to eat as it pleased and to balance its own diet. Grits, ground charcoal, and fresh water were accessible to each lot all the time.

EXPERIMENT AND RESULTS

WEIGHT OF HENS

To determine whether the feeds had any effect on the weight of the birds, each bird was weighed at the beginning and at the end of the experiment. Hens of Lot A gained an average of 221 grams in 7 months, while those of Lot B gained 173 grams.

FEEDING

Care was taken in feeding each lot. The self-feeders used were kept always under observation and the supply of supplements ran down continually into the trough. The amount of feed supplied and consumed by each lot was carefully measured and recorded. Table I shows the chemical analyses of the feeds used as analyzed at the College Chemistry Laboratory.

TABLE I.—*Showing the chemical analysis of the feeds.*

Feeds.	Shell.	Meat.	Moisture.	Fat.	Crude protein.	Carbohydrate.	Crude fiber.	Ash.	Undetermined.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Snail.....	51.56	48 44	78 22	0.75	7.62	7.31		6.06	.04
Corn. ...			12.48	4.91	9 37	69.77	1 93	1 54	.00
Palay....			11.21	8 63	9.50	58.01	5.01	6.88	.76
Rice bran			10 53	15 80	10.98	40 98	9 10	12 61	.00

EGG PRODUCTION

The eggs laid by each hen of each lot were carefully recorded. That egg production by each hen could be determined without difficulty, eight good trap nests were provided for each lot.

The eggs were gathered three times a day, at nine o'clock, at noon, and at five o'clock in the afternoon. Every egg that was laid and collected was numbered with the corresponding number of the hen that laid it and was recorded to her credit.

That comparative data on the weight of the eggs laid could be secured, every egg laid was weighed and recorded. The average weight of 494 eggs laid by Lot A was 41.62 grams., and of 335 eggs laid by Lot B was 39.67.

Calculation was made also on the cost of feed consumed and the value of the eggs produced by the hens of each lot, so as to determine which of the feeds used was the more economical for egg production.

MORTALITY

All the birds of each lot were carefully observed for any disease or other ailment. Any hen that died or showed a decidedly abnormal condition was immediately replaced with a new hen of practically the same age.

One hen died November 18, 1921. Post mortem examination showed that every part of her internal organs was normal. The only trouble found was that an egg ready for expulsion was broken right in the oviduct and this was suspected to be the cause of her death. The egg was probably broken as a result of some accident. Another hen was removed October 7, 1921, because of her extraordinarily fat condition; she had laid no egg since the beginning of the experiment.

These two hens were replaced by two others as soon as they were removed from the lots.

DISCUSSION OF RESULTS

All the birds in both lots, except one in Lot B, gained in weight, but the hens of Lot A gained more in weight than those of Lot B.

TABLE II.—*Showing amount and cost of feed consumed, number and value of eggs produced, and gain over cost of feed.*

Lot.	Grain.	Ground corn.	Rice bran.	Snail.	Total cost.	Total number of eggs.	Value of eggs.	Gain over cost of feed.
	kg.	*kg.*	*kg.*	*kg.*			*pesos*	*pesos*
Lot A. Ground corn, rice bran, and snail-fed.....	107.5	44.5	80.62	86.2		494	34 58	+14.45
Cost...	₱9.84	₱3.71	₱3.74	₱2.84	₱20.13			
Lot B. Ground corn and rice bran-fed..........	107.5	46.07	120.9			335	23.45	+4.16
Cost...	₱9.84	₱3.84	₱5.61		₱19.29			

Table II shows the amount of feeds consumed by the birds of each lot during the course of the experiment. From this table it may be seen that the hens of both lots consumed the same amount of basal ration as each lot was given the same amount. Lot A (fed ground corn, rice bran, and snail) consumed a larger amount of supplement than Lot B (fed ground corn and rice bran). Lot B, however, consumed more rice bran and ground corn than Lot A.

In connection with the amount of feed consumed by the birds of each lot it may be mentioned that the computed nutritive ratios were 1:7.1 for Lot A and 1:7.7 for Lot B.[2]

However, it can be seen from the hens of Lot A that one of the evident results of the addition of snail to the supplement was an increased food intake which naturally stimulated fattening and greater egg production.

A sample of snail used was analyzed by the Chemistry Department and was found to consist of 51.56 per cent shell which contains largely calcium, an element essential in the formation of the egg shell, and 48.44 per cent meat. The meat consists of 0.75 per cent fat, 7.31 per cent carbohydrate, and 7.62 per cent crude protein, and 6.06 per cent ash. Here it can be seen that snail contains a good deal of the materials necessary for egg production. The broken shell of the snail also forms a good grit, a thing which is very essential in the process of digestion of the birds.

In all cases, during the seven months of the experiment the hens of Lot A had a higher monthly rate of egg production than the hens in Lot B. Lot A produced 494 eggs in seven months and Lot B produced 335 eggs in the same length of time, giving a difference of 159 eggs in favor of Lot A. The average egg production in Lot A was 49.4 eggs a hen for seven months and 33.5 eggs

[2] The nutritive ratio was computed from the total amount of each part of the basal and supplemental rations consumed by the birds of Lot A and Lot B and from the chemical analyses of the samples of the same feeds. Nutritive ratio = (per cent fat x 2.25) plus per cent carbohydrate divided by per cent crude protein.

a hen for the same length of time for Lot B. This shows that the supplement consisting of ground corn, rice bran, and snail was better for egg production than the supplement consisting of ground corn and rice bran alone.

In Lot A there were five hens that made a slight gain in weight and five other hens of the same lot made marked gains. Those that made slight gains produced 287 eggs in seven months, or an average of 57 eggs a bird while those that made marked gains produced 210 eggs in the same length of time, or an average of 42 eggs a bird. In Lot B, there were three hens that made slight gains in weight, and there were five hens of the same lot that made marked gains. The total number of eggs produced in seven months by the three that made slight gains in weight was 137, or an average of 45.66 eggs a bird, and in the same length of time the five that made marked gains in weight produced 122 eggs, or an average of 24.5 eggs a bird. These figures show that in both lots the hens that made slight gain in weight during the course of the experiment laid more eggs than the hens that made marked gain in weight. The figures also support the common observation that the fat birds after the laying season are usually the idlers. Among individuals that are subjected to about the same treatment there are always some individuals that are better producers than others. Hence, the importance of selecting hens for maximum egg production.

Buenaventura (7) in his experiment, planned to parallel the work here reported, found that the ten hens of his Lot A (fed ground corn, rice bran, and cowpeas) gave a total production of 456 eggs for seven months and the ten hens in his Lot B (fed ground corn, rice bran and copra meal) gave 295 eggs for the same length of time. In Lot A there was an average of 45.6 eggs a hen, and 29.5 eggs in Lot B. The total eggs produced by the ten hens in Lot A (fed ground corn, rice bran, and snail) of the experiment here reported was 494 eggs for seven months or an average of 49.4 eggs a bird. This number of eggs was higher than either that of Lot A or Lot B in Buenaventura's work. This fact tends to show that a ration, the supplement of which contained snail was slightly more efficient for egg production than a ration the supplement of which contained cowpeas, and vastly more efficient than one containing copra meal.

The total weight of the 494 eggs in Lot A was 20,558.7 grams, or an average of 41.62 grams per egg, while that of the 335 eggs in Lot B was 13,289 grams, or an average of 39.67 grams per egg. This shows that the eggs produced by the birds with ground corn, rice bran, and snail for their supplement were slightly heavier than those produced by the birds which were given only ground corn and rice bran. The difference was probably due to the greater amount of available protein and mineral matter in the feed of the former than in that of the latter.

The average number of eggs a bird in Lot A was practically the same as that in Lot B before the study began. During the experimental period, hens of Lot A improved very much over their previous egg production while those of Lot B made practically no improvement at all. This is shown by the fact that the previous average of egg production a bird for seven months was 32.87 eggs for Lot A and 33 eggs for Lot B, while the average production of eggs a bird for the same length of time during the experimental period was 49.4 eggs for the former and 33.5 eggs for the latter. This fact also seems to show plainly that the supplement consisting of ground corn, rice bran, and snail was more efficient for egg production than the supplement consisting of ground corn and rice bran alone.

Table II shows the relative cost of egg production from each lot. In the computation of the cost of feed consumed, only the basal and the supplemental feeds were considered. The computation was based on actual prices of feeds in this locality. They were as follows: Corn and ground corn at ₱1.00 per 100 ears shelling on an average 12 kilograms or 8.33 centavos a kilogram; rice, palay at ₱4.30 a cavan, or 10 centavos a kilogram; rice bran at ₱1.30 a cavan of 28 kilograms or 4.64 centavos per kilogram; twelve liters of snail for 40 centavos, or 3.3 centavos per liter which is approximately 1 kilogram.

Eggs sold at 7 centavos each.

By reference to Table II it may be seen that at the prices quoted the total expenses for the feed consumed in Lot A was ₱20.13 and the total value of the eggs was ₱34.58 making a net gain of ₱14.45 over the cost of feeds. The cost of the feeds consumed by hens in Lot B was ₱19.29, and the total value of the eggs was ₱23.45, a net gain of ₱4.16 over the cost of feeds. Comparing the gain from the lots, it is seen that Lot A was $10.29 greater than Lot B. This shows that it was more economical to use ground corn, rice bran, and snail for supplement than to use ground corn and rice bran alone.

SUMMARY AND CONCLUSIONS

1. All the birds in both lots, except one in Lot B, gained in weight. The average gain a bird was more marked in Lot A (fed ground corn, rice bran, and snail) than the average gain in Lot B (fed ground corn and rice bran).

2. Lot A consumed a greater amount of feed than Lot B. Both lots consumed the same amount of basal feed, but Lot B consumed a greater amount of corn meal and rice bran than Lot A. The greater consumption by Lot B was especially marked in the rice bran. The computed nutritive ratio was 1:7.1 for Lot A and 1:7.7 for Lot B.

3. Lot A produced 494 eggs in seven months, while Lot B produced 335 eggs in the same length of time. This shows that the birds fed with a supplement consisting of corn meal, rice bran, and snail, were better egg producers than those which were fed with supplement consisting of corn meal and rice bran alone. The hens in each lot which were heavy layers made but slight increase in their weight while those that were poor layers made marked gains. The comparison in egg production for the same length of time, between Lot A (snail-fed) of this experiment and that of either Lot A (cowpea-fed) or Lot B (copra meal-fed) of Buenaventura, shows that the former gave 494 eggs and the latter two gave 451 eggs and 294 eggs respectively. This seems to indicate that snail is a better supplement for egg production than either cowpea or copra meal.

4. The eggs laid by the birds fed with ground corn, rice bran, and snail were heavier than those laid by the birds fed only with ground corn and rice bran alone.

5. All the hens in Lot A made marked improvement in egg production during the experimental period compared with that of their previous record, while Lot B practically did not improve at all. This shows that supplement consisting of ground corn, rice bran, and snail, was much better for egg production than that which consisted of ground corn and rice bran alone.

6. The hens of Lot A made a net gain of ₱14.45 and those of Lot B ₱4.16. The cost of feed consumed by each lot was almost the same. This shows that

it was more econominal to produce eggs with the addition of snail to rice bran and ground corn than without it. (Table II.)

RECOMMENDATIONS

1. Snail (crushed and cooked), whenever available and not expensive, is a very good supplement to the ration of laying hens.

2. Once good egg layers are selected, hopper feeding of dry mash as a supplement to a scratch ration of whole grains, is recommended. This method allows the hens to balance their own diet, thus saving labor and attention, besides promoting cleanliness in feeding.

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STUMBLING IN HORSES[1]

By Louis P. Koster
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Faulty action in horses is always annoying and no defect is more troublesome than that of stumbling. Not only may the animal inflict serious injury upon itself but the safety of the occupants of a vehicle may be endangered by its occurrence. When the horse is under saddle stumbling is a constant menace to the rider and may be followed by the most direful consequences. Efforts at correction are usually without avail and the time-worn adage "once a stumbler, always a stumbler," bears eloquent testimony to this fact. The purpose of the present article is to correct certain misconceptions in regard to stumbling and to direct attention to, and to emphasize the importance of, certain mechanical features which are not generally recognized as being associated with the act.

Stumbling may be defined as that defect in gait in which the foot of a swinging foreleg comes in premature contact with the ground while that member is still more or less flexed. While this definition is substantially correct, it is misleading to the extent that by inference it designates the swinging leg as the one at fault, whereas just the opposite is the case, as the fault exists in the supporting leg, as will be shown later. Fatigue, overlong toes, and natural awkwardness are frequently given as causes of stumbling by interfering with or delaying the "breaking over" process at the toe, thereby preventing sufficient elevation of the foot during the stride to clear all ordinary obstacles. Such an assumption definitely accuses the swinging leg as the offending member and creates a distinctly erroneous impression. The small measure of success that attends efforts aimed at increasing the height of the stride and facilitating the "breaking over" process of the foot is significantly indicative of the fallacy of the theory. The problem is to be viewed primarily from the standpoint of the supporting leg.

Close observation of an inveterate stumbler in motion will disclose, that just before, but almost coincident with stumbling, there occurs a slight bending of the knee of the leg bearing the body weight. The yielding of the supporting column permits the body to drop to the extent of allowing the toe of the foot of the swinging leg to strike the ground while being carried forward and there follows a temporary and whole or partial loss of body equilibrium.

DEGREES OF STUMBLING

The extent to which the animal retains or loses control of its balance will depend upon the position of the free limb at the time the supporting leg gives way. Thus, different degrees of stumbling are to be recognized.

Should the swinging leg occupy a position just anterior to the supporting leg when the latter yields, the animal will, by a quick movement and by throwing up the head, generally be successful in advancing the swinging leg in time to catch and support the weight of the body. When a horse recovers himself in this manner without falling he is said to have made a "misstep" or to have merely

[1] Experiment Station contribution No. 195.

"stubbed his toe". In such case the toe comes in contact with the ground while it is being extended and brought forward and a little earth or scratched surface may be found on the toe of the shoe or lower part of the wall at the toe.

Should the supporting leg yield at that stage in the phase of flight when the knee of the swinging leg is only slightly in advance of it and when extension of the swinging leg from the fetlock down has not yet commenced, that part of the swinging leg from the fetlock down will be forced against the ground. The animal while falling may be seen to make one or more desperate efforts to regain its feet, but the swinging leg is fast against the ground and cannot possibly be released and extended. This condition could only result from the animal's weight having been thrown upon the leg before that member was in a position to receive and support it. An inspection of the limb after the accident will reveal a mark along the entire front of the foot and an injury extending along the front of the coronary border, the pastern, and the fetlock joint. The nature of the injuries, particularly the upward thrusting of the hair, clearly indicates that they have been caused by the part having been forced backward against the ground. The horse goes down by plunging forward and, if the driver pulls hard on the reins, the animal may be prevented from extending its head and neck, thus making the collapse so complete that the inside of the lips may be cut with the incisor teeth through the chin coming in contact with the ground. This explanation also serves to show the absurdity of the statement commonly made by riders and drivers that they have "held up" a horse while stumbling.

Should the foot of the swinging leg occupy a position in line with or slightly behind the supporting leg at the time of stumbling a portion of the front part of the foot will be forced against the ground and the animal's efforts to regain its feet will be unsuccessful to the extent of causing both knees to be injured. These differences in stumbling are of degree only and are dependent upon the position the swinging leg occupies at the time the supporting leg yields.

THE CAUSES OF STUMBLING

The great majority of cases of stumbling, possibly as much as 90 per cent, are the result of the supportive structures of the limb carrying the body weight being out of proper alignment and relation with each other. This condition is due to faulty conformation or more often to a so called unbalanced foot, that is, one the supporting surface of which has been left uneven and not level by injudicious trimming of the hoof or faulty fitting of the shoe.

When in motion the free limb makes contact with the ground and the body weight is shifted upon it, its direction at first is oblique from above to below and from behind to before. During the phase of flight of the opposite limb the body gradually moves forward upon the supporting limb, the foot of which serves as the pivotal point. As a consequence, during progression the direction assumed by the supporting leg gradually changes until it becomes by degrees first vertical and then oblique from before to behind. It follows, therefore, that the burden of supporting the body weight is transferred successively from one part of the fixed leg to another while these changes in its direction are taking place and we may infer that the part of the supporting leg undergoing the greatest amount of strain, or subjected to the greatest change, will be indicated by the position of the swinging limb at the time stumbling occurs. Since the position occupied by the free

limb can be determined by the degree of stumbling we may consistently conclude that in all cases of stumbling where the animal does not fall, the position of the supporting limb is vertical.

The center of gravity of the body is displaced at every step and the weight is constantly being transferred from one limb to another when locomotion is in progress. The body is falling and nothing but the timely arrival of the opposite limb to a position where it can catch and support it will prevent its falling to the ground. The limb was intended to perform this function and is normally provided with the necessary strength, not only when in a vertical position, but its many parts are so arranged and adjusted as to permit of a change in its position without detracting from its strength and comfort.

When the body weight is first received upon the extended limb the incidence is from above and in a downward and backward direction and strain falls largely upon the strong and more or less elastic structures located in the posterior part of the leg. The foot being fixed upon the ground as the body moves forward the position of the limb approaches the vertical and the weight passes through its center and through that part of the foot known as the quarters. This is the crucial stage and the quarters must now be depended upon. If for any reason, insufficient support is given to one side, the limb will suddenly be displaced in that direction and injury to the lateral ligaments will often compel the animal to yield to the increased strain. The cause of insufficient support being given to one side of the limb is due to some condition, either pathological or mechanical, which renders the limb unable to bear pressure on that side with comfort and as a result it yields and permits the body to drop. The tendons have full control over extension and flexion and, though not possessing much elasticity in themselves, they are still capable through the muscles above, of which they are in reality continuations, of adjusting their length to the extent of escaping injury. The ligaments, on the other hand, while playing a very important part in preventing or at least limiting, movement of the joints to either side, are non-elastic, or only very slightly so, and are unable to adjust themselves to an abnormal position.

While any condition which prevents a limb from performing its function with ease and comfort may be a cause of stumbling, diseased and pathological alterations, particularly those giving rise to lameness, are not apt to do so, for the reason that lame horses in traveling prevent to some extent the weight of the body falling upon the affected member. "Breaking over," which is essentially stumbling behind, can, however, often be accepted as a symptom of incipient spavin.

METHODS OF CORRECTION

Bearing the foregoing considerations in mind, it seems reasonable to assume that any collapse, whole or partial, in the supporting leg must of necessity be due to a lateral displacement of the weight borne by the limb since the structures of the front and rear of that member adjust themselves to unusual conditions with great facility. Furthermore, whether stumbling is caused mechanically, or is due to the presence of an abnormal or pathological condition in the limb, the result is due to weight being imposed upon some part not capable of sustaining it. Our object therefore must be to change the incidence of the weight to some other and stronger part. If the fetlock joint is inclined to the inside of an imaginary

line dividing the limb into lateral halves, the support of the limb in that direction must be increased. This may be accomplished by fitting the shoe full or flush on the inside of the foot and close or base narrow on the outside. If the opposite is the case the conditions and the remedy will be reversed. All deviations in a lateral direction from the normal alignment of the bones of the limbs are due either to faulty conformation or to a faulty base of support and the latter is chiefly attributable to the foot not being level. When these two factors co-exist, as not infrequently happens, the effect on the inclination of the limb is, of course, exaggerated. An even tread of the foot and uniform wear of the shoe must be obtained. To do this, when trimming the hoof, the bearing surface must be made as nearly level as possible. Unfortunately there is no reliable guide for the shoer to follow in this operation, entire dependence must be placed upon his intuitive faculty or mechanical "eye."

As regards the fitting of the shoe, every part of the coronary region in the posterior part of the foot must receive support from the shoe below. If, for example, the outer quarter at the coronet projects beyond its plantar border the outer branch of the shoe from the last nail hole back must be fitted so full that an imaginary line dropped from the coronary band will fall just in line with the outer border of the shoe. Upon examining a foot from the rear the distance from the center of the frog to the two heels should be equal. A simple but quite useful method of determining whether or not the work of the foot and limb is properly distributed is to raise the opposite foot, thereby throwing all the weight upon the limb being examined. If the horny structure growing from the back of the fetlock joint and known as the "ergot" is found to occupy a position directly over the depression between the bulbs of the heels the weight on the limb may be considered as being equitably distributed. If shoeing is performed in accordance with the foregoing principles great improvement in the gait of many horses will be effected even though manifest unsoundness exists in the limbs. Occasional stumbling will, of course, occur in any animal whether sound or unsound, and well shod or otherwise. Such cases are referable to the animal stepping upon a loose stone or into a depression of the road; conditions which obviously cannot well be avoided.

IMPROVING PHILIPPINE SWINE: I[1]

By B. M. Gonzalez and F. P. Lago

Of the Department of Animal Husbandry

In 1916 when the senior author took charge of the animal husbandry work in this College there were in the department a number of individuals of two improved breeds of swine, the Berkshire and the Duroc Jersey. These hogs were from the Bureau of Agriculture. Some of them were animals imported direct from the United States, but the majority were born at the Alabang Stock Farm, the offspring of imported animals.

These pure bred hogs formed a nucleus for a herd of Berkshire and Duroc Jersey breeds in the College. We desire to give here for the information and guidance of raisers of improved swine the record of these animals, and the results of later efforts. Records such as these are rarely found in print, for people rather talk of their successes than of their failures. As to whether these records show our failures or that of the animals, we leave to the reader to decide. We do not know of any improved breed of swine that is fully established in the Islands, or, to be more specific, one in its fifth generation or beyond. Many hog men have tried raising the improved breeds but with experiences similar to what we give in this paper.

THE DUROC JERSEY AND ITS GRADES

PURE DUROC JERSEYS

There were one boar and six sows in the original herd. Three out of the six sows produced litters averaging six pigs each. One of them farrowed twice. The boar and five of the sows died of kidney worms some time between the age of one year and one and a half years. The other sow was in good condition but would not breed. She was butchered and was found to be heavily infested with kidney worms. From our experience with this disease we feel pretty certain that this animal would have died from it in time.

We raised a second generation of pure breeds from this stock, consisting of four males and two females. The average length of life of these six animals was 185 days, varying from 62 to 232 days. Post mortem findings indicated that they all died of kidney worms, in some cases associated with lung worms. None of the females farrowed. This was the last of the pure herd.

BERKSHIRE X DUROC JERSEY

After the Duroc Jersey boar died, there was left one of the original Duroc Jersey sows, which remained in good condition. This was bred to a Berkshire boar. From this was raised a litter of six pigs, the average length of life of which was 211 days, ranging from 99 to 316 days. Our records show that these animals all died of kidney and lung worms. As none of them bred, this cross ended with these individuals.

[1] Experiment Station contribution No. 196.

DUROC JERSEY X NATIVE

Two native sows were bred to a Duroc boar, one of them producing three litters, and the other, one, with a total of 24 pigs or 6 pigs to a litter. Six of these pigs died rather young. Of those that remained, 6 out of 18, or 33 per cent, were females, of which only one farrowed, a litter of three pigs which she was not able to raise. All these sows died of kidney worms at an average age of 382 days. The remaining 12 of the 18 pigs, 4 males and 8 females, were finally butchered or sold. The boar pigs showed no promise of turning into good individuals and were castrated. Four females were bred to the Berkshire boar and farrowed once each and raised 5 out of a total of 14 pigs born, or an average of three and one-half pigs to each litter and one and one-fourth pigs raised to each sow and litter. The more promising of the sows were kept for over two years, but never farrowed again.

DUROC JERSEY-NATIVE X BERKSHIRE

The progeny of these grade sows out of a Berkshire boar, which were 50 per cent Berkshire, 25 per cent Duroc Jersey, and 25 per cent Native, were four males and one female.

Their length of life averaged 249 days; they died of either kidney worms or hog cholera, without leaving any progeny. This was the end of the Duroc-Native cross, as well as of any Duroc blood in our herd from this introduction.

THE BERKSHIRE AND ITS GRADES

PURE BERKSHIRES

During the last seven years we have introduced into the College 18 Berkshire pigs, 5 boars and 13 sows. These have been introduced at various times.

With the exception of one which was unable to impregnate at times sows known to be fertile, all the boars were fully fertile. Three boars died having lived on an average about two and a half years; the shortest life being two years. All these animals died of kidney worms. Two boars are still living and are apparently in perfect health; they are now about two years old.

Of the 13 sows, 7 have proven absolutely sterile. Of the remaining six, one farrowed dead pigs, five farrowed an average of 5.8 pigs each; three of these raised two pigs a piece. Those that are dead had an average length of life of 783 days. Some of these sows never came in heat, but the majority took the boar but never farrowed. Two of these sterile sows are still living. They are approximately two years old, have been bred repeatedly but never farrowed.

Six sow pigs from three mothers were raised from the introduced stock. Three died of kidney worms leaving no progeny; two when about six months old, and the other when a year and a half of age. Three are still living. They are approximately two and a half years old now, have bred but not farrowed.

From the facts given above, one can see that the outlook for continuing the production of pure bred Berkshires is not at all promising.

BERKSHIRE X NATIVE

Observations and experience both in the College and elsewhere had led the senior author to have grave doubts of success with the pure breeds. Accordingly a program of grading up native swine was begun as soon as possible. The success of our efforts with the use of the Duroc Jersey breed has been described above.

Among Native pigs in these Islands, those coming from Jala-Jala, a town in Rizal Province, have long held a reputation for relatively good size and conformation, early maturity, and especially for the quality of quick and economical fattening. They have these characteristics in addition to the more general characteristics of Native pigs of high fertility and of being good mothers. For these reasons, this strain was selected on which to build up our grading work.

Three sow pigs were purchased in 1915 by Mr. José Cui, a former student of the College. When these pigs matured they were bred to pure breed boars and they gave us in all 90 pigs in 14 litters, an average of almost 5 litters to each sow and six and a half pigs to a litter. They lived approximately four years and finally succumbed to kidney worms, all dying within one month.

We wish to emphasize the following facts in this connection; these three sows were housed, cared for, and fed exactly the same rations as all the other pigs in our care. They reproduced regularly under these conditions. It seems to be a fair assumption, therefore, that there is nothing radically wrong with our conditions. The behavior of these sows may be looked upon as a standard with which the crosses may be compared.

Our pigs in this project have been numbered consecutively since the beginning of this work and in this discussion only the solid block of numbers representing the pigs already dead, from disease, or slaughtered, and those sold, are included. A limit had to be selected, as our remaining pigs are of different ages and nothing can be foretold of their future behavior. This number includes practically all pigs born before August 5, 1920.

Fifty-eight pigs are recorded as being 50-50 Berkshire-Native grades. Twenty-four of these were either sold or butchered and 34 died at an average age of 343 days. Eight of the latter, or 23 per cent, died of kidney worms at an average age of 500 days. Other causes of death were hog cholera, intestinal parasites, emaciation due to obscure causes, etc. Of 14 sows that lived at least a year and a half, or 548 days, only 4, or 29 per cent, proved fertile. The rest were slaughtered at an average age of 630 days. The 4 fertile sows gave us 45 pigs in six litters or an average of seven and a half pigs to a litter. One of them, No. 97, is credited with 22 pigs and three litters. There were other sows which farrowed but died before they were one and a half years old.

There were 30 pigs out of first grade Berkshires by a Berkshire boar (75-25). Using the common breeder's term we shall designate them as three-fourths Berkshires. Nineteen of these were either sold or butchered. Eleven died at an average age of 363 days, two of kidney worms, and the rest of hog cholera. Of four sows that lived over a year and half, or 547 days, two were fertile, Nos. 114 and 135. No. 114 gave us two litters with a total of 16 pigs before she died. Sow 135 is still living. She is the last pig in the series included in this study; she was included because all her litter-mates are and she has already proven her ability as a breeder. She is now three years old and has already given us three litters. She traces back to the prolific sow No. 97 mentioned in a previous paragraph. We have followed and are following up the progeny of these two sows. We have pigs now two generations removed from these animals. They are the concrete result of seven years efforts in the improvement of native swine. These animals have gone through the most rigid test of natural and artificial selection. They have been exposed continuously to kidney worm infestation and have de-

veloped a high degree of resistance to it. They have also gone through a severe epizootic of hog cholera, in which we lost 64 per cent of our herd.[3] Their vitality and fertility have been the object of very close selection. The result of our further efforts in the improvement of Philippine swine using these two sows as a basis will be the subject of another paper.

KIDNEY WORMS

As may be noted in the foregoing discussion, kidney worm infestation was the most active agent in causing the mortality of the pigs. A summary table is here presented.

TABLE I.—*Pigs dying a natural death.*

BREED	Total number.	Average age.	Died of kidney worms.	Average age.	Per cent.
		days		*days*	
Duroc Jersey (introduced)	7	450	6	470	85
Duroc Jersey (locally raised)	6	185	6	185	100
Berkshire x Duroc Jersey	6	211	6	211	100
Duroc Jersey x Native	6	382	6	382	100
Duroc Jersey-Native x Berkshire	4	249	2	220	50
Berkshire (introduced)	10	769	7	841	70
Berkshire (locally raised)	3	310	3	310	100
Natives (introduced)	4	1137	2	1270	50
Berkshire x Native (50-50)	34	343	8	500	23
Berkshire x Native (75-25)	11	363	2	407	18

The percentage of mortality from kidney worms of improved breeds is noticeably high, especially when it is considered that most of them died young. Comparing the pure breeds raised in the Animal Husbandry Department with those brought in, there was a higher mortality among those locally raised. This may be due to the lowering of the resistance of the animals through long residence under adverse conditions.

The high percentage of mortality among the native sows is more apparent than real. These animals lived about their span of life. They had to die of some cause through weakened resistance due to old age, and so fell victim to kidney worms. The two other native sows died of hog cholera, at a comparatively young age. The improved resistance of Berkshire-Native crosses is very evident.

Observation throughout the Islands has shown that kidney worm is the most serious disease of improved breeds. This condition is aggravated by the fact that the disease is present in Native pigs and so is very widespread. Native pigs, however, are very resistant to it, few if any young Native pigs die from it, but they are a continuous source of infection to foreign pigs.

The kidney worm (*Stephanurus dentatus*) is a worm cylindrical in shape, rounded at the extremities, and about an inch to two inches long. Its color is

[3] GONZALEZ, B. M. Hog cholera at the College of Agriculture. Philippine Agriculturist, 10: 347-348. 1922.

irregular, because the contents of the alimentary canal show through its transparent skin thus making it gray or dark in patches. It attacks the liver principally, also the fat around the kidneys, the kidneys themselves, and the spleen to some extent. It may lodge itself in the ureters, thus blocking urinary passage and causing uremic poisoning. The symptoms are most variable. The animal apparently may be in good health, yet drop dead suddenly without much of a warning or a preliminary period of illness, but usually the affected animals are greatly emaciated and weaken gradually until death. In some cases there is diarrhœa; while in others, constipation. The urine is highly colored and voided with some difficulty. Upon examination of the dead animal the organs affected are revealed to be putrid, discolored, and filled with the debris of the worm. The worm itself is found. There is no treatment known, but chances of infection from native pigs may be minimized by keeping pure breeds apart from them, and by exercising the utmost cleanliness in the pens and paddocks.

FERTILITY

Another evident failing of pure breeds under our conditions is the poor fertility of the sows. The accompanying table illustrates this point concisely. While comparatively newly imported sows are fairly fertile, they apparently degenerate steadily with each succeeding generation. It seems as though their vitality (if non-fertility may be taken as a sign of weakened vitality) holds on for some time but finally gives way due to the unsuitableness of the environment. None of our pure breed sow pigs locally raised showed signs of fertility. All the pure breed males that we have had were fertile. The grade sows, as may be expected, were better. Infertility among native swine while comparatively low is not as rare as one might suppose from casual observation.

TABLE II.—*Fertility of sows.*

	No. of sow pigs raised.	Sows attaining 1 yr. age or over.	No. Fertile.	Fertile.
				per cent
Duroc Jersey (introduced)	6	6	3	50
Duroc Jersey (locally raised)	2	0	0	0
Berkshire x Duroc Jersey	1	0	0	0
Duroc Jersey x Native	13	10	5	50
Duroc Jersey-Native x Berkshire	1	0	0	0
Berkshire (introduced)	13	12	6	50
Berkshire (locally raised)	6	4	0	0
Native (introduced)	10	10	8	80
Bershire x Native (50-50)	32	24	8	33
Berkshire x Native (75-25)	16	7	2	17

SUMMARY

In this first report of our efforts to improve Philippine swine, a detailed review of the results of introducing pure breeds of swine, that is, Duroc Jersey and Berk-

shire are presented. At least, under our conditions, the perpetuation of pure breeds has proven impossible because of kidney worms. Our efforts to grade up Native swine with Duroc Jerseys have also failed. Grading up with Berkshires, while accompanied with great difficulties, because of deaths caused by kidney worms especially, and poor vitality and low fertility, have left enough individuals that have stood all the tests of the environment. These animals are now being utilized to form the foundation of an improved breed better adapted to Philippine conditions.

COLLEGE AND ALUMNI NOTES

Dr. Robert L. Pendleton, formerly Director of Agriculture, Gwalior State, India, has been appointed Professor of Soil Technology and is in charge of the work in soils in the Department of Agronomy. He graduated from the University of California with the degree of Ph. D. in 1917, and from 1918 to the date of his appointment here worked in India directing experimental and demonstration work in agronomy, animal husbandry, and veterinary science. His division will be housed in the new building which is being erected by the bridge.

The Los Baños Intramural Track and Field Meet will be held in November. Teams will, as usual, be divided by classes and the winners will constitute the nucleus of the Unit IV (Colleges of Agriculture, Veterinary Science and Forest School) inter-collegiate team.

With the forfeiting by the College of Engineering of their basket ball game with Unit IV on October 28, Unit IV retains its sixth successive championship in basket ball. With the return of Rabaya to the Forest School Unit IV has material for three basket ball teams any one of which is thoroughly competent to hold the University Championship.

The College of Agriculture through the work of Calvo, Oliveros, Batao, and Villa was first University Champion in boxing. The College received the first award of the Captain Davis Cup which is to be awarded annually for this sport.

The Unit IV baseball team representing the Colleges of Agriculture, Veterinary Science and Forest School team won two games from the Tayabas Provincial High School at Lucena on October 27 and 28. The team was accompanied by Professor Hester, Doctors Montemayor and San Agustin. Inasmuch as Unit IV has held the University Championship for several years past the team represents the entire University and plays under the colors of the institution. The fact that the athletes were entertained at *thé dansant* at the Provincial Dormitory for Girls on the afternoon of the first game is expected to bring out many more candidates for the squad.

Dr. G. O. Ocfemia returned to the Islands in September after three years study at the University of Wisconsin. He majored in plant pathology under Professor L. R. Jones, and took botany and agricultural bacteriology as his minor subjects. His research problems were in connection with the Helminthosporium disease of rice occurring in the Southern United States and in the Philippines. Doctor Ocfemia has resumed his former position as instructor in plant pathology.

Loyalty Day, October 10, was fittingly observed in the College of Agriculture, the only College of the University of the Philippines in which it is an official holiday. The day's program consisted of a military parade of the local regiment of the U. P. Corps of Cadets and a literary program in the morning, and a military competition which occupied the entire afternoon.

Felix B. Sarao, '17, was recently appointed instructor in Animal Husbandry in this College. Mr. Sarao was employed in the Department of Mindanao and Sulu from 1917 to 1920, and in 1920-1921, he was with Doctor Copeland in Chico, California. He attended the University of Wisconsin in 1921-1922, from which he was graduated with the degree of Master of Science in June 1922, majoring in dairy husbandry. Before returning to the Islands Mr. Sarao worked for a time as a farm help on a dairy farm in West Allis, Wisconsin.

Among the delegates to the annual convention of the Philippine Sugar Association who visited the College on October 7, 1923, were the following alumni of the College of Agriculture: Tranquilino D. Ventura '19 of the Pampanga Sugar Development Company; Jose C. Miraflores, '15 of Manapla, Occidental Negros; Andres P. Goseco, '20, of Guagua, Pampanga; Silvestre Asuncion, '12, who is in charge of sugar cane investigation work of the Bureau of Agriculture, and Jose Q. Dacanay, also from the Bureau of Agriculture.

Doctor Uichanco of the Department of Entomology, and Doctor Mendiola of the Department of Agronomy visited Paete, Laguna, during the latter part of the month of September to investigate the abaca heart-rot situation in that locality. Abaca heart-rot is a serious menace to the hemp industry in the Islands.

Perpetuo Gavarra, '23, is back in the College taking some post-graduate courses in agronomy. Mr. Gavarra was one of the active officers of the Second Regiment of the U. P. Corps of Cadets during his last year in the College.

Doctor Fronda of the Animal Husbandry staff, accompanied by his class in advanced poultry husbandry, visited the Alabang Stock Farm on October 6. Mr. Alcasid, '19, the superintendent of the farm, showed the party around the plant.

Ambrosio Abesamis, '21, is now in charge of the cattle breeding station of the Bureau of Agriculture at Bayombong, Nueva Vizcaya. Mr. Abesamis was formerly stationed at the stock farm of the Bureau in Alabang, Rizal.

Felix Telado, '22, is a travelling agricultural assistant in British North Borneo. He arrived there May 6, 1923. His present post office address is Sandakan, British North Borneo.

Simeon Panganiban, '20, is in charge of the Lanao Cattle Ranch located at Malabang, Lanao. He writes that there are thousands and thousands of hectares of public land around Malabang, Lanao, available for interested alumni. The principal crops around that region are coconut, sugar cane, rice, and corn.

Guillermo Tabios, a former student of this College, writes that he is now running his own stock farm which is located just opposite the place of Mr. Florentino Cruz, '16. Mr. Tabios' stock consists of 50 head of excellent native cattle and Indian bulls. In 1921 Mr. Tabios was in charge of the government ranch in Bukidnon for some time.

The Rizal Center Fraternity at Los Baños has recently inaugurated monthly literary meetings. At the first meeting, in September, papers were read by Dr. R. B. Espino, the Supreme Noble of the Fraternity and Mr. Pedro Rodrigo, Noble Secretary. At the October meeting Mr. Zósimo Montemayor read a very interesting article on capital and interest; Mr. Antonio Luzuriaga held his audience with Warden's well-known chapter on Friendship; and while Mr. Fausto Natalio read Milton's Purity of Life.

from household industries. Reducing the annual income to the hectare basis, the total is ₱132 per hectare; of which sum ₱80 was derived from the land; ₱37, from secondary occupations; and ₱15 from household industries. The percentages are shown graphically in Figure 6.

LAND OWNERSHIP AMONG TENANTS

[Statistical Appendix, Section XIII]

According to Spillman and Goldenweiser (8) and Taylor (32) tenancy in the United States is a step towards ownership. Taylor states "while tenancy is common at the present time and has been present in the United States since the beginning of our nation, it has been looked upon merely as a stepping stone, a temporary means of acquiring the use of land, and not as a permanent condition for any individual."

In six surveys an investigation of landownership on the part of the tenants was made. The results showed that for the 740 tenants investigated 313 had acquired an average of 1.3 hectares for each owner or.5 hectares for each tenant. In 80 per cent of the cases this was the area on which their houses had been built and was not to be held as agricultural land. Only in Hagonoy and in Aparri, limited areas of true farm land had been cleared from public domain and unclaimed areas near by. The average farm land acquired by each owner was a little less than one hectare, or one tenth of a hectare for each of the 740 tenants surveyed. The average length of tenure was 6.8 years, therefore the rate of acquisition of land by the tenant was .0147 of a hectare per annum. The average tenancy consisted of 2.4 hectares. It would therefore take 163 years for the average tenant to acquire a piece of land equal in area to his present holding if he continued at the existing rate of land acquisition.

TENANTS' INDEBTEDNESS

[Statistical Appendix, Section XIV]

Philippine tenancy, especially of rice land, is heavily weighted with debt. Tenants accept, indeed, require advances, which are granted by the landlords at rates of interest which appear exceptionally high unless the low security is taken into consideration. In general the loans consist of three kinds: (a) *Quasi consumptive loans* which include advances in rice and in money for the purchase of fish, made by the landlord during a period of from one to four months before harvest for the purpose of furnishing subsistence to the tenant. After the tenant has paid interest on former debts out of his share of the harvest he seldom has enough rice left in his share to last him until the following harvest. In addition, the tenant not infrequently sells a part of his share and throws himself and his family upon the landlord's mercy. The landlord has no option but to furnish the loan, because if he does not the tenant will leave, the land will remain uncultivated, and the landlord will have acquired a reputation for hardness and lack of sympathy. Although these loans are fundamentally consumptive, from the standpoint of the landlord they are economic and productive. The landlord has no alternative but to offset the almost total absence of security with a usurious rate of interest. The rate is seldom objected to or questioned by the tenant. (b) *Consumptive loans* are made generally in cash granted by the landlord to the tenant for the purpose of supplying the outlay for a tenant marriage, baptism or funeral, ceremonies which in the Philippines involve the spreading of

feasts and expenditures of time and money out of proportion to all other points in the standard of living. Not infrequently a funeral will cost the tenant's family in money and food a sum equal to one half of their annual income. (c) *Productive loans* are frequently made during the course of harvesting or preparation of land. They are made in cash and frequently by a third party. The third party is usually a rice buyer. He attaches the crop for collection in kind at prices prevailing immediately subsequent to harvest and at a fairly high rate of interest.

Miller (4) quotes Mr. Percy A. Hill's description of the prevailing advance and debt systems under *kasama* tenure in the rice region of Central Luzon. According to Hill the tenant receives first, upon entry into the contract, an advance in cash called *bugnos* which varies from ₱15 to ₱70. He also receives a ration of palay, one half cavan at the end of each week, and repays the landlord after harvest without interest. Any money advanced is paid in *taclanan*,[31] that is, the landlord after harvest is repaid in palay at from 50 to 75 centavos a cavan which means in an average year an interest rate of from 150 to 200 per cent. After planting the crop, the loan system is based on commodity advances, termed *terkiaan*,[31] and *takipan*,[31] which carry interest rates of from 50 to 100 per cent. Principal and interest being collectible, if possible, in palay at harvest. On large plantations the *patuid*,[32] or settlement of debts between landlords and tenants is not made with any regularity and the tenant has no accurate knowledge of the amount of his interest and principal. In practically all cases the accounts are in the hands of the landlord. For the payment of principal and interest, which is constantly growing until it acquires impossible dimensions, the work of the tenant, of his wife and children, is demanded. When the children are old enough, if they have not been educated, they enter as tenants working on the parental debts and new debts acquired by themselves. On the tenant's death, the principal and part of the interest invariably remain unpaid, and are passed down to the next generation. Bankruptcy is considered dishonorable and the son who refuses to accept the debts of his father is an outcast in his own community.

Investigation on indebtedness of tenants was attempted in each of the eight surveys; but more reluctance and less accuracy was evident on this point than on all others combined. The landlords would not permit the checking of the data. The data must stand only as a very tentative and partial review of the actual conditions.

Number and amount of loans.—For the surveys, all eight having reported on this point, there were found 433 out of 830 investigated who were encumbered with 589 separate loans. The proportion of indebted tenants was therefore 52 per cent. The average amount of indebtedness for each encumbered tenant was ₱57.62; the average for each tenant of the surveys, ₱30.01; the average for each hectare, ₱12.63.

Source and classification of loans.—Of the total amount of all loans, 84 per cent were from the landlord; 16 per cent from third parties; 60 per cent, classified as either quasi-consumptive or consumptive; 40 per cent, classified as productive.

[31] Pangasinan, types of advances or loans as explained.
[32] Tagalog, literally, "to draw a straight line".

Rates of interest.—Computation of an average rate of interest was not possible, inasmuch as loans repayable in rice result in basing the actual rate on the market price of rice at time of repayment. Some of the investigators, however. stated their estimates on current rates of interest as follows. Rodis (20) reported for Naic, 35 per cent as minimum rate and 390 as maximum. Teruel (15) reported for Tigbauan a range of from 60 to 66 per cent interest on landlord loans during the preceding year (1920). Santamaria (16) gave 133 per cent as the average in San Miguel.

Length of loans.—The length of consumptive loans was either entirely indefinite or "until next harvest". Even the next harvest would frequently find extensions granted at a higher rate of interest.

Relation of indebtedness to farm income.—The average indebtedness per hectare was approximately 16 per cent of the average farm income per hectare per annum.

Relation of indebtedness to investment.—The average indebtedness per hectare was approximately 9 per cent of the average investment per hectare.

Membership in Rural Credit Societies.—Only one tenant of the surveys was reported a member of any of the numerous Co-operative Rural Credit Associations, had any deposit therein, or enjoyed any loan therefrom. No tenant was reported as having deposits in the Postal Savings Bank or in other savings institutions.

The usury laws.—Usury laws were not enforced. The tenants were aware of them but had the honor not to apply to courts to set aside verbal agreements which had been sought by them. No law is of practical benefit when it is to the interest of both law breaking parties to persist in breaking the law, for the simple reason that there are no complainants or informers. Usury laws are enforced in the Philippines sporadically and sensationally. Usury is a natural circumstance, symptomatic, and not a cause.

Likewise, with banks and credit facilities, they cannot be advocated as cures. Economic improvement depends upon industry, ingenuity, and thrift. Frequently in the Islands we find the theory, even in legislative halls, that the economic life of the nation is founded upon banks, or a bank; that a few credit institutions scattered through the provinces may become the basis of a rural renaissance. Nothing is further from the truth. Banks and credit associations are not primary factors in production, nor have they ever been *fundaments* of the economic life of a nation. They are only mechanisms and both economic success and failure lie far deeper than credit, banking or usury.

POPULATION OF TENANCIES

[Statistical Appendix, Section XV]

Carver (33) is entirely serious and fundamental when he writes, "the policy of agricultural statesmanship is, or always should be, to preserve those conditions which will secure a large product *for* each worker rather than merely to secure a large product *from* each acre of land." A review of tenancy without consideration of the tenant and his family as social beings would be a travesty. The eight surveys were constituted to comprise the social elements of the problem under several headings, the first of which is an analysis of the family.

General population.—The surveys covered 830 tenants of which 690 maintained households. There were 775 husbands or widowers; 771 wives or widows;

50 unmarried tenants; 1,780 dependent living children; and 388 dependents other than children; constituting a total of 3,764, the tenant population which derives its living from the tenants' shares plus the income from secondary and household occupations.

Self-supporting children.—There were reported 449 children of tenants who were self-supporting and no longer a burden to the area. They are not included in the population.

Deceased children.—The report on deceased children was not complete. Many tenants did not report children who died at birth or very early in infancy. The number of deceased children reported was 1,527. Comparison with the living children indicates a child mortality of 41 per cent.

Dependents.—The dependents were largely near relatives of the family who had been less fortunate or who had reached old age. These were received into the household as a matter of course. Of the commendable elements of the Filipino social system that may be recorded, not the least is he lack of poorhouses. Unfortunate people are received always by their scarcely more prosperous relatives as members of the family and sharers of the common standard. There is neither grudge nor philanthropy in the matter, simply the somber adherence to fixed tradition.

The average living family.—Census Office (6) places the average living family at 5.54 persons, while the surveys gave 4.6 as the average. It would be possible for anti-Malthusianists to conclude that there are parts of the globe, other than France, where the family is limited by the lowering of the standard of life.

The average household.—Census office (6) gives 5.98 as the average number of persons for each dwelling which included hotels and boarding houses. The surveys found 5.3 as an average for true organized family households.

Density of population.—Census Office (6) gives the density of population of the Philippine Islands as 90 per square mile or nearly .35 per hectare. Although the general density of the Islands is relatively low, the specific density is high, Bureau of Commerce and Industry (9) lists for 1918, four provinces with densities per square mile of over 450; two, with over 300; nine, with over 200; fifteen, with over 100; and nineteen, with less than 100. In short, but 6 per cent of the Philippine land area is cultivated and the density becomes about 1088 per cultivated square mile, or 4.25 per hectare of cultivated land.

To arrive at the specific density for the surveys it is necessary to consider the tenants and their households as living, not on the entire area, but on the actual area from which their share was derived, thus eliminating the landlord element both in population and supporting area. According to the typical contract the tenant received half of the crop less seed, less harvesters' share. The seed being negligible was disregarded. Also, as the "third parties" who worked as harvesters were more frequently other tenants of the same estate or district, and as the system was in reality exchange group labor, it was assumed that each tenant received for helping in the harvest of other holdings as much as he paid out of his share to harvesters on his own holding. The effective cultivated area of the surveys was 2086.3 hectares of which 1043 may be logically taken as the supporting area of the 3,764 of tenant population. Specific density for the tenant population of the surveys was, therefore, 3.6 persons per hectare or 921 per square mile.

Per capita area.—In the last analysis of any problem in rural economy, population must be clearly related to area if logical conclusions are to be drawn. For the entire islands, computing from Census Office (6), the per capita cultivated area is .25 hectares, or about .62 acres; for the survey, .28 hectares, or nearly .7 acres. While there is always danger in the finality of comparing interracial standards of living, it is significant that the average Filipino, as well as the tenant of the surveys, must draw practically his entire wealth, for the Islands are all but conclusively agricultural, from a cultivated area less than one-quarter that required to produce the standard ration for a private in the United States Army as shown by Carver (34) on the basis of United States Army Regulations, 1913, corrected to April 15, 1917.

AGE OF TENANTS

[Statistical Appendix, Section XVI]

The average age of the tenants was 41 years. The average age is important as indicating that the Philippine rice tenant is not an apprentice on the lower rung of an agricultural ladder which leads through degrees of advancement to ownership at prime of life. Additional evidence on this point was given under *Land Ownership among Tenants*.

SEX AND MARITAL CONDITION OF TENANTS

[Statistical Appendix, Section XVII]

Although there are listed in Bureau of Commerce and Industry (35) 730,102 female agricultural laborers, the surveys discovered only three female tenants. The figure quoted, which was probably computed from Census Office (6), is either out of proportion or else, as seems more likely, includes wives and daughters of the families of both tenants and peasants who commonly share in the planting and harvesting of crops. The three female tenants discovered in the surveys were widows temporarily carrying on after the death of their husbands.

Of the 830 tenants: 770 were married; 7 were widowers; 3 were widows; and 50 were single. It is quite apparent that tenancy is socially designed, as indeed is every type of farming, for the family unit.

The average age at marriage was 22 years for the men and about 18 for the women. There is a loosely held opinion that Filipinos in common with other Oriental peoples marry at an early age. The data of the surveys show a contrary fact.

INTERMARRIAGE AMONG TENANTS

[Statistical Appendix, Section XVIII]

The Philippine Islands are divided into 43 ethnic groups by Professor Beyer (36). These groups, with the exception of the Mohammedan and pagan elements, which because of their isolation from the balance of the population may be disregarded, present no social deterrent to the upper strata of the population but are very efficacious limits in the lower strata. Further the Filipino social fabric recognizes the town as the essential center and for the ignorant *tao* (peasant) its limits are his generic horizon. The barrio, a subdivision of a town, contains in the rural districts from 10 to 200 houses and families. For the six surveys which collected data on intermarriage, it was found that 60 per cent of the tenants had married within their native barrio; 86 per cent had married within their native town; and 95 per cent within their native province. Nor is the tenant class the

least mobile of the lower elements of Filipino society. The tenant lies midway between the laborer who may be characterized as slightly mobile and the peasant who is minutely geographically fixed. The presence of an 86 per cent communal intermarriage is here recorded as an interesting social fact.

NUMBER AND AGE OF TENANTS' CHILDREN

[Statistical Appendix, Section XIX]

Under *Population* certain facts regarding the children of tenants have been presented. Further analysis shows the following relative to these members of the family. Of the 2,229 living children: 1,780, or 80 per cent were dependent. Of the dependent children: 827, or 47 per cent were of six years of age or less; 705, or 39 per cent were from 7 to 18 years of age; and 248, or 14 per cent were 19 years of age or over. Of all living children: 449, or only 20 per cent were self-supporting. Of the self-supporting children: 61, or 14 per cent were 7 to 18 years of age and 388, or 86 per cent were 19 years of age or over. The adult children, 19 or over, numbered 636, and of this number 248 or more than one third remained on the holding. The reason for this is patent—they are needed to assist the family over the high labor-peaks of the planting and harvesting seasons.

Considering the ages of all living children: 827, or 37 per cent were 6 years of age or less; 766, or 34 per cent were from 7 to 18 years of age; and 636, or 29 per cent were 19 years of age or over. The low percentages in the two upper age groups as compared with the lowest age group is due to the 41 per cent child mortality.

LITERACY OF TENANT FAMILIES

[Statistical Appendix, Section XX]

Literacy was designated as *vernacular* when the subject was able to read and write in any one of the numerous Philippine languages. Reading was not taken to mean ability to interpret a signboard or notice, but capacity to read a vernacular book or periodical. Writing was not confined to name signing, but was judged on ability to readily inscribe a business letter. Spanish and English literacy were gauged on the basis of equal facility in reading or writing in those languages, with the exception, that all children in school of whatever grade were adjudged literate. Literacy in Spanish or English invariably carried with it literacy in the vernacular. Although neither Spanish nor English school instruction includes a native dialect, yet the normal progress in Roman literation enables the student to record spoken vernacular into written vernacular. Literacy in English did not carry literacy in Spanish as a general rule, although there appeared a surprising number of cases in which Spanish literacy had been acquired subsequent to English literacy. The results for the eight surveys are presented under three heads.

Literacy of tenants and wives.—The literacy of the older generation was 40 per cent, comprised of: literacy in vernacular only, 34 per cent; literacy in Spanish and vernacular, two per cent; and literacy in English and vernacular, four per cent. The remarkable character of this fraction of the survey is that twice as many of the older generation are literate in English as are literate in Spanish.

Literacy of tenants' children.—The literacy of the younger generation was 54 per cent composed of: literacy in the vernacular only, 18 per cent; literacy in Spanish and the vernacular, two per cent; and literacy in English and the vernacular, 34 per cent.

General literacy.—Throwing both generations together, the literacy was 48 per cent, divided: literacy in the vernacular only, 25 per cent; literacy in Spanish and vernacular two per cent; and literacy in English and vernacular 21 per cent.

Comparative literacy of generations.—A striking fact brought out in the data is that the younger generation is only one-third more literate than the older generation. The gain in English literacy being offset by a loss in the vernacular, only, literacy. There has, cf course, been an almost complete decadence of religious and secular vernacular schools, but the English schools reach practically every barrio of the Archipelago. Tenants complained that in the earlier days of the English school system, there had been a very sudden closing of vernacular schools and it was not until relatively recent years that the English schools had been sufficiently numerous or near enough at hand to offset the closing of the vernacular schools. Statistical data on this point, through not available, would probably refute the complaint. There never was, on the average, more than one religious vernacular school in a parish, a parish being almost limitrophe with a town; whereas by 1915, not only had every town its English speaking primary school, but also about one third of the barrios.

Another apology offered for younger children without schooling was the overcrowding of barrio schools and the turning away of applicants for registration. There is good foundation for this as nearly every schoolhouse in the Philippines during the past five years has witnessed the turning away of pupils because of inadequate facilities.

Vernacular schools.—Secular schools in the vernacular were reported only from Calasiao where according to Royeca (19):

> Instruction in the vernacular was given by a native "teacher," who studied Spanish grammar in the reading of pamphlets, namely, the *caton*, the *cartilla*, and the *libro* and in writing. The former two pamphlets were used by the beginners in studying reading. The last was a religious book, composed of prayers translated into Pangasinan and it was used after finishing the former two. In cases of a few advanced students, Spanish grammar was taught. The *impanhibilar*, a dialect story was taught by a neighbor or a relative who knew how to read and in return for his or her instruction the pupils would do some light task in the house. The pupils paid the "teacher" twenty centavos every month and fifty centavos extra if he took the course in Spanish grammar.

CLASS STABILITY

[Statistical Appendix, Section XXI]

The question of the "agricultural ladder" so frequently, and perhaps unwarrantedly, used in relation to American tenancy has no place in Philippine tenancy. To justify this thesis, an investigation covered all surveys on the point of the occupations of tenants' relatives and relatives' husbands. If any large portion were to be found who were landowners the "ladder" theory might be applied. The 830 tenants surveyed, reported on 7,478 relatives including only fathers, fathers-in-law, brothers, brothers-in-law, sisters, sisters-in-law, sons, and sons-in-law. Of these relatives, 68 per cent were either tenants or married

to tenants while only 1.6 per cent were landed proprietors or peasants. The imputation is fair that Philippine rice tenants are a definite strata, a stable class in the rural life of the Islands, and there is very little rising from that status to a better agrarian one. The material lies for the crystallization of a class of peons resembling closely that pitiable group in rural Mexico.

CHARACTER OF DWELLINGS

There were three types of dwellings according to construction. The *bamboo-nipa* type which accounted for over 80 per cent of all dwellings. These houses are constructed as follows: (a) Hard-wood corner posts; (b) bamboo frame; (c) woven bamboo or nipa-thatch walls; (d) nipa-thatch roof; and (e) bamboo slat floors; with (f) frame, walls and roof bound together with rattan filets. This type of house commonly consisted of one room with a kitchen lean-to and rarely an extra bedroom. The *mixed material* type of dwelling differed from the first type, only in having the frame entirely of hard wood and in the use of nails. About 18 per cent of all dwellings were of mixed materials. Such dwellings averaged two rooms with a kitchen lean-to. The *strong materials* type of dwelling was entirely of hard wood, except the roof which in rural Philippines is invariably of nipa palm thatch. There were only two per cent of dwellings of this type. The strong material house will generally have three rooms and kitchen.

Over 95 per cent of all houses were without toilet facilities, yet 95 per cent of all houses were located within 10 meters of other houses.

RECREATION

Each of the six surveys was investigated on this point. Santa Rosa, Hagonoy, Calasiao, Naic, Aparri, and Bay listed the cockpit and gambling at cards, annual fiestas of the patron Saints of the barrios, and fiestas at the sacraments, as the chief forms of amusement of the older generation. Athletics, especially indoor baseball, was very popular with the younger school element.

Sobriety was exemplary. Only at fiestas and political rallies were intoxicating beverages indulged in and then with moderation.

None of the tenants, except at Naic, reported membership in lodges or organizations. It is forbidden by their landlords. However, there is little doubt but that a large number of the tenants at Hagonoy were members of either the *Magsasaka* or of the *Union de Aparceros de Filipinas*, as was every tenant at Naic. There were many more or less temporary religious co-fraternities to which the tenants belonged from time to time.

The great majority of the tenants held with varying degrees of devotion to the Roman Church. There were a few Protestants and at Santa Rosa a majority of tenants investigated belonged to the Philippine Church.

POLITICAL STATUS

The political status of tenants is rather obscure. About two-thirds were electors and of these electors, a majority reported that they voted as their landlords wished them to. The case is well stated by Santos (18):

> It was generally expected that the tenants would follow the political belief of their landlords. The writer observed in the regions surveyed that the tenants' votes were practically at the discretion of their landlords in matters of politics. The tenants were not in a position to independently choose among the political candidates in an election campaign. And if the tenant exhibited any independence in this matter he would lose his holding. It

was commonly understood that the tenant was a follower of his landlord and was expected at all elections to vote for his landlord's candidates.

TENANT AGGRESSION

Tenant aggression was reported only from Naic. Rodis (20) wrote as follows:

> The association was founded in April, 1921, by Mr. Jacinto Manahan, vice-president of the *Union de Aparceros de Filipinas* (Union of Share Tenants of the Philippines), who actively spread propaganda against landlord oppression and high "rent" shares. Mr. Manahan had previously aroused the tenants of Bulacan province. He perfected the organization in all six barrios considered in this survey. The barrio units are united under one common head into a federation. The federation is headed by a single man, Pablo Talob, a tenant of this survey. Talob is one of the more prosperous tenants of the region, about 45 years old, of irreproachable character, never has held any political office, seeks none, has the full confidence of his neighbors, is a man of great intelligence and thoroughly literate in Tagalog and Spanish.
>
> The *Magsasaka* (farmers) contended actively for the following points:
>
> 1. To reduce the amount of *buis* given to the land to the amount equal to what the landlords in other municipalities of Cavite are requiring their tenants to give.
> 2. To eliminate the extra labor required in the landlord's household, such as getting water, repairing of dwellings, etc., when the tenant borrows money or palay in case of necessity.
> 3. To cut down the high interest on loans, which ranges from 35 to 390 per cent per annum.
>
> The organization has met with resistance from the landlords, who have, themselves, organized. At first they discharged tenants who joined the tenants' association. This, however, soon proved ineffective and is no longer followed. The landlords, in general, refuse to accede to any of the demands of the *Magsasaka*, although there have been a few exceptions.
>
> The harvest in December, 1921, was made a test. The trouble was just beginning at the time of closing the survey. But up to date, March, 1922, according to a letter from Mr. Marcelino Constantino, Farm Adviser in the province of Cavite, the tenants have not paid the *buis*. There have resulted numerous instances of crop-burning, assault, guarding fields, and attacking farmers with shotguns and a general agrarian rupture is in progress at this date. The tenants have sworn not to give the *buis* and in cases of its being collected forcibly, the tenants have agreed not to plant for the current year.
>
> Landlords have spread among the tenants the fictitious menace of importation of Japanese field workers. This is impossible under the American immigration laws which hold for the Philippines, and as many of the tenants know this the threat does not serve to frighten many of them. The landlords are in a poor position to fight, as they are themselves paying for the land on twenty year installments to the Philippine Government, which in 1907 purchased the area from Friars—a part of the famed "Taft Purchase". About half of their installments have been paid. The *buis* is a conscious and deliberate system of the landlords to take the payment for the land out of the tenants' shares of the crops. In nearly every case the *buis* equals the installment, and in not a few, it is greater.

It must be noted that in this, the only case of aggression, there exists a decided abuse—a deviation from the typical contract in favor of the landlord.

SUMMARY

The fractional conclusions of the discussion may be listed as follows:

Area.—The average gross area of the Philippine rice tenancies under survey was 2.4 hectares; the average cultivated area was 99.7 per cent of the gross area; and the effective area, 106 per cent of the gross area. The average gross area was less than that for all Philippines share tenancies while the average cultivated

area and average effective area were considerably greater due to the levying of the surveys in regions of high density and complete cultivation.

The area is admittedly small due to continued *morcellment* through inheritance without primogeniture; the unwillingness of the tenant class to forego the advantages of the barrio social order; the lack of a well administered social policy of public land alienation; and the intensive culture on a one-crop system which delimits area by two high labor peaks— preparation of land and harvesting.

Crops.—The entire area surveyed was planted to rice with an incidental diversification of 8.2 per cent of the area.

Tenure.—The average length of tenure was nearly seven years.

Eighteen per cent of the tenants engaged in from two to four separate tenant contracts.

Causes of shifting were: controversy with landlord; area too limited; and abolition of tenancy, principally through enclosures for plantation crops.

Contract.—The typical contract was verbal and customary and arranged on a half-and-half share basis with the landlord supplying the land, and the tenant both the labor and capital goods. Notable modifications were found in favor of the tenant in regions where labor was scarce and equally notable modifications in favor of the landlord, on tenancies comprising parts of government-purchased, re-parcelled friar estates so that the landlord shifted two thirds of the payments for the land to the tenant's shoulders.

Purchase by the government, re-parcelling, and installment sale of friar estates had not resulted, as intended, in placing land in the hands of "tillers of the soil" but in passing the land over to a particularly grasping set of untraditioned, subsidized landlords.

Supervision.—Forty-three per cent of the area surveyed was under complete supervision of the landlords; 35 per cent was under intermittent supervision; and 22 per cent was under ineffective supervision.

Formal salaried foremen were not discovered.

Intermittent supervision was more extensively characterized by controversy between landlord and tenant than was the case under either of the other two types of supervision.

Farm labor time.—The average labor time was 299 hours per hectare per annum which is excessively small as compared with available data from China and Japan. No one may expect a "living" from so limited a quantity of labor.

The distribution by processes was 39 per cent to preparation of land; 7 per cent to planting and transplanting; 13 per cent to cultivation; 30 per cent to harvesting; and 11 per cent to general labor.

The seasonal distribution was very faulty with the first month (preparation) and the first half of the seventh month (harvesting) taxing the labor supply while the other months of the farm year were relatively unoccupied. The faulty distribution was largely due to lack of diversification.

The greater the area, the less was the labor on one hectare.

The entire family was concerned in the labor time.

Animal labor.—The carabao was indispensable in preparation of the land and useful in harvest and general labor. For every hour of human labor there was approximately one-half hour of animal labor.

Investment.—The tenant being generally responsible for all capital goods, had on the average an investment of ₱143 per hectare, divided: 35 per cent in dwellings and yards; 1 per cent in farm purpose buildings; 8 per cent in implements and vehicles; and 56 per cent in work animals.

The greater the area, the less was the average investment for one hectare.

Farm income.—The average tenant's share of the farm income was ₱80 per hectare per annum. After deducting interest on investment at eight per cent and depreciation at 12 per cent, the income left the tenant and his family an hour wage of 17 centavos as against current wage for agricultural laborers of eight centavos, and for municipal school teachers and master carpenters of 38 and 36 centavos, respectively.

The greater the area, the less was the income from one hectare.

Justification of typical contract.—The typical contract was just, in that after subtracting costs, which for the tenant included wages, from net incomes, the landlord and tenant both recived 12 per cent interest on investment. The shortcomings in Philippine tenancy cannot be generally laid on an inequitable contract.

Secondary occupations.—Seventy-nine per cent of all tenants were engaged in one or more secondary occupations. These enterprises occupied 41 per cent of the tenant's total labor time.

The claim that the rice tenant is more nearly a jack-of-all-trades than a farmer was substantiated as was to be expected from the meanness of the annual farm labor time, 299 hours, and its inefficient distribution.

The income from secondary occupations averaged ₱37 per hectare per annum or 46 per cent of the income from land alone.

The smaller the area, the more extensive was the devotion to secondary occupations.

Household industries.—Fifty-five per cent of the households were engaged in home industries, chiefly embroidery and hat making.

The income from this source averaged ₱15 per hectare per annum, or 19 per cent of the income from the land alone.

The source of total family income was 60 per cent from the land; 28 per cent from secondary occupations; and 12 per cent from household industries.

Landownership among tenants.—The fact that it would take 163 years for the average tenant to acquire ownership of farm land equal to his admittedly too small present holding at his existing rate of land acquisition, leaves little stability for the "ladder theory" of tenancy as a step towards ownership in the Philippines.

Tenant indebtedness.—Inconclusive data was derived on this point, but apparently the average landlord is weighted under a serious burden of usurious loans in commodities and advances in cash, principally from his landlord and largely used for consumptive purposes, especially for the sacraments of marriage, baptism, and death, and to a less degree for gambling and fiestas. The tenant sought the loans and gladly accepted them at unheard-of rates of interest.

Indebtedness was one method of enabling landlords to retain their tenants.

The indebtedness was inherited from father to son—primogeniture in debt and *morcellment* of land.

Membership in Co-operative Rural Credit Associations and deposits in savings banks were negative findings for the tenant.

Banks and credits are not to be accepted as solutions of tenant conditions.

Population.—The population showed a specific density of 3.6 per hectare, or 921 per square mile thus allowing the average tenant .28 of hectare, or .7 of an acre from which to derive all his wealth, whereas it requires four times that area to supply the food of the average private in the United States Army. The same average holds for the entire Philippine population.

The average living family was 4.6 persons as compared with 5.54 for the entire Archipelago.

The average household, by the addition of dependents to and substraction of self-supporting children from the average living family, totaled 5.3 persons.

Age.—The average age of tenants was 41 years, denying the applicability of tenancy furnishing the first step during youth towards proprietorship at prime of life.

Sex and marital condition.—All tenants were males with the exception of three widows carrying on to harvest the tenancies of their recently deceased husbands.

Ninety-five per cent of the tenants had been married at an average age of 22 years.

Intermarriage.—That the tenant class is immobile and gregarious is indicated by the fact that 60 per cent of all tenants married within their native barrio; 86 per cent within their native town; and 95 per cent within their native. province. Yet the tenant is less fixed, geographically, than the peasant proprietor.

Number and ages of children.—The 830 tenants reported 2,229 living children and 1,527 deceased children, indicating a child mortality of 41 per cent.

Eighty per cent of living children were dependent, of whom 14 per cent were over 19 years of age staying at home apparently as helpers.

Of all children: 37 per cent were six years of age or less; 34 per cent were from 7 to 19 years of age; and 29 per cent were 19 years of age or over.

Literacy.—The first generation consisting of the tenants, their wives and adult dependents, showed 40 per cent literacy, comprising: 34 per cent literate in the vernacular only; two per cent in Spanish and vernacular; and four per cent in English and vernacular.

The second generation, the children, showed 54 per cent literacy, comprising: 18 per cent literate in the vernacular only; two per cent, in Spanish and vernacular; and 34 per cent, in English and vernacular.

English and Spanish literacy almost automatically carried with it vernacular literacy.

The second generation was one-third more literate than the first.

Spanish literacy was negligible in either generation. Even in the older generation twice as many were literate in English as in Spanish.

Vernacular, secular, and religious schools have declined.

The English-speaking barrio primary schools are not numerous enough to accommodate the children who apply.

Class stability.—The tenants reported on relatives: 68 per cent as tenants or married to tenants and but 1.6 per cent landowners. The tenants today constitute an almost fixed caste and elevation to proprietorship does not occur.

Crystallization of a peon class is possible.

Dwellings.—The house of the tenant was typically a one room and kitchen bamboo *cubo*.

Recreations.—Cockpits, gambling, and fiestas were the principal forms of tenant amusement.

Sobriety was the rule among the tenants.

Membership in tenants' unions was reported only from Naic but may have existed elsewhere, particularly in Hagonoy.

The majority of tenants belong to the Roman Church.

Political status.—While two thirds of the tenants were electors, they commonly admitted their electoral control by the landlords.

Aggression.—Active resistance of tenants was reported only from Naic.

CONCLUSIONS

To correlate the results in the nature of a diagnosis is difficult. The results of the surveys have the advantage of priority in the field rather than that of extent. The conclusions must be taken as applying particularly to the limits of the investigation and as only generally indicative of the entire area of rice tenancy in the Philippine Islands.

1. The area of the tenancies was too small as shown by: (a) Reasons offered for shifting; (b) A small farm labor-time, too small to warrant a living in any urban occupation; (c) The engagement in secondary occupations by 79 per cent of the tenants; (d) The prevalence of household industries in 55 per cent of tenant homes; (e) The relative inefficiency of the smaller areas as compared with the larger areas on the points of labor-time and investment; (f) The excessively high specific density of population; and (g) A consequent per capita area too small to afford a decent standard of living. On the contrary, the tenant apparently does not know how to handle a large area economically as shown by the fact that the lower incomes per hectare were derived from the only slightly larger areas.

2. The desire for greater area cannot be satisfied: (a) In the over-populated rice districts where there is a continuous *morcellment* of land; nor (b) In the public domain until the tenant is educated away from his gregariousness, until the alienation of public land is rendered more efficient.

3. Philippine tenancy is in the primitive one-crop system abandoned in Europe, Japan, and China centuries ago, and as a result the distribution of labor-time is extremely faulty. This cannot be corrected until diversification is practiced.

4. The existing typical contract is just and equitable.

5. There is no indication that tenancy is a step towards ownership for: (a) The average age of the tenant places him beyond the prime of life; (b) The tenant is acquiring farm land at a rate calculated to take 163 years to obtain proprietorship of an area equal to his present holding; and (c) Over two thirds of his relatives are tenants and practically none are landowners.

6. The tenant is gregarious rather than individualistic in nature.

7. The tenant is in a state of unrest and is organizing. Organization cannot go far in modifying in the tenant's favor an already equitable contract—it can only correct occasional abuses.

8. The tenant class is becoming more literate and it is to be hoped that education will provide him so intense a desire to consume that he will surrender his gregarious habits, become a pioneer into a well administered domain, and produce to the fullness of his desire not as a tenant but as a freeholder.

RECOMMENDATIONS

Social investigation is barren unless accompanied by conservative practical recommendations. There are but a few and they follow:

1. For the good of the present generation of tenants it is necessary to provide an agricultural reform that does not require either greater area or higher labor-peaks on rice tenancies. The most obvious way of doing this is to determine for each locality that variety of rice which will give the best return and actively engage in seed selection within that variety. The average yield of rice in the Philippines is slightly over 20 cavans to the hectare, while from the College of Agriculture there have been reported yields from selected varieties and seed running above 40 cavans to the hectare without fertilization. Why has so-called modern agricultural administration and education existed for twenty years in the Philippines without reflecting itself in an added grain of rice per hectare? This is the one most immediate and practicable detail. In the light of this problem the devotion of so much administrative energy to coffee, citrus, adlay, and even sugar is incontestibly short-sighted.

2. Systems of diversification, preferably with legumes, should be provided for the near future.

3. In order that the next generation shall have adequate areas, a fixed policy for the alienation of the public domain, with titles, should be held to. The administration of the homestead laws should be tightened to the last notch. Claim-jumping, land grabbing, political connivance therein, and shystering land lawyers should be awarded sudden and harsh justice.

4. At whatever necessary cost to higher non-technical education and indeed to all other departments of government save only the maintenance of order and justice and the administration of agriculture and the domain, funds must be found to provide all children with a primary education.

The story of the tenant of the present generation is largely written; but what of the next? Shall he be a peon or a member of that most absent and needed of all Philippine liberties—a free middle class? Let it everywhere be said, be believed, and be acted upon that, "This nation cannot endure without a thrifty rural middle class—and it is *my* duty to help in its establishment."

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ILLUSTRATIONS

STATISTICAL APPENDIX

I. AREA

A) Tigbauan

1) Number of tenants in survey		50
2) Gross area of survey	ha.	129.4
a) Average area for each tenant		2.6
b) Maximum area for one tenant		10.0
c) Minimum area for one tenant		0.3
d) Modal area for one tenant		3.1–4.0
i) Percentage of tenants in mode		28.
3) Cultivated area of survey	ha.	129.4
a) Percentage of gross area		100.
4) Effective area of survey[1]	ha.	129.4
a) Percentage of gross area		100.
b) Percentage of area in 1st crops		100.

B) San Miguel

1) Number of tenants in survey		40
2) Gross area of survey	ha.	114.5
a) Average area for each tenant		2.9
b) Maximum area for one tenant		6.5
c) Minimum area for one tenant		2.0
d) Modal area for one tenant		2.0–3.0
i) Percentage of tenants in mode		90.
3) Cultivated area of survey	ha.	114.5
a) Percentage of gross area		100.
4) Effective area of survey	ha.	114.5
a) Percentage of gross area		100.
b) Percentage of area in 1st crops		100.

C) Santa Rosa[2]

1) Number of tenants in survey		81
2) Gross area of survey	ha.	380.3
a) Average area for each tenant		4.7
b) Maximum area for one tenant		8.4
c) Minimum area for one tenant		0.2
d) Modal area for one tenant		3.1–4.5
i) Percentage of tenants in mode		26.
3) Cultivated area of survey	ha.	380.3
a) Percentage of gross area		100.
4) Effective area of survey	ha.	492.4
a) Percentage of gross area		129.5
b) Percentage of area in 1st crops		100.
c) Percentage of area in 2nd crops		29.5

D) Hagonoy

1) Number of tenants in survey		138.
2) Gross area of survey	ha.	439.0
a) Average area for each tenant		3.2
b) Maximum area for one tenant		10.0
c) Minimum area for one tenant		0.3
d) Modal area for one tenant		2.6–3.0
i) Percentage of tenants in mode		20.0
3) Cultivated area of survey	ha.	439.0
a) Percentage of gross area		100.
4) Effective area of survey	ha.	439.0
a) Percentage of gross area		100.
b) Percentage of area in 1st crops		100

[1] The effective area includes the consideration of areas planted to two crops within the same year.

[2] The community is favored by an extensive irrigation system constructed by Dominican Friars over a century ago which avails, for alternate halves of the municipality, a second crop each year.

E) *Calasiao*

1) Number of tenants in survey		99.
2) Gross area of survey	ha.	97.0
a) Average area for each tenant		1.0
b) Maximum area for one tenant		2.7
c) Minimum area for one tenant		0.2
d) Modal area for one tenant		0.4–1.2
i) Percentage of tenants in mode		68.
3) Cultivated area of survey	ha.	94.6
a) Percentage of gross area		97.5
4) Effective area of survey	ha	100.2
a) Percentage of gross area		103.1
b) Percentage of area in 1st crops		97.7
c) Percentage of area in 2nd crops		5 4

F) *Naic*

1) Number of tenants in survey		151.
2) Gross area of survey	ha.	288.0
a) Average area for each tenant		1.9
b) Maximum area for one tenant		5.7
c) Minimum area for one tenant		0.5
d) Modal area for one tenant		1 5–2.0
i) Percentage of tenants in mode		34.
3) Cultivated area of survey	ha.	283.8
a) Percentage of gross area		98.5
4) Effective area of survey	ha.	283.8
a) Percentage of gross area		98.5
b) Percentage of area in 1st crops		98.5

G) *Aparri*

1) Number of tenants in survey		111.
2) Gross area of survey	ha.	190.0
a) Average area for each tenant		1.7
b) Maximum area for one tenant		8.0
c) Minimum area for one tenant		0.1
d) Modal area for one tenant		0.1–1.0
i) Percentage of tenants in mode		42.
3) Cultivated area of survey	ha.	190 0
a) Percentage of gross area		100.
4) Effective area of survey	ha.	190.0
a) Percentage of gross area		100.
b) Percentage of area in 1st crops		100.

H) *Bay*

1) Number of tenants in survey		160
2) Gross area of survey	ha.	337.0
a) Average area for each tenant		2.1
b) Maximum area for one tenant		10.0
c) Minimum area for one tenant		0.5
d) Modal area for one tenant		1.6–2.0
i) Percentage of tenants in mode		25.0
3) Cultivated area of survey	ha.	337.0
a) Percentage of gross area		100.
4) Effective area of survey	ha.	337.0
a) Percentage of gross area		100.
b) Percentage of area in 1st crops		100.

I) *All surveys*

1) Number of tenants in the surveys		830.
2) Gross area of survey	ha.	1975.2
a) Average area for each tenant		2.4
b) Maximum area for one tenant		10.0
c) Minimum area for one tenant		0.1
3) Cultivated area of survey	ha.	1968.6
a) Percentage of gross area		99.7
4) Effective area of survey	ha.	2086.3
a) Percentage of gross area		106.0
b) Percentage of area in 1st crops		99.6
c) Percentage of area in 2nd crops		6.4

II. CROPS

A) *Tigbauan*

1) Effective area of survey	ha.	129.4
a) In rice, 1st crop		95.0
b) In maize, 1st crop		27.9
c) In sugar		4.3
e) In vegetables and fruits		2.2

B) *San Miguel*

1) Effective area of survey	ha.	114.5
a) In rice, 1st crop		114.5

C) *Santa Rosa*

1) Effective area of survey	ha.	492.4
a) In rice		492.4
i) 1st crop		380.3
ii) 2nd crop		112.1

D) *Hagonoy*

1) Effective area of survey	ha.	439.0
a) In rice, 1st crop		413.0
b) In maize, 1st crop		13.8
c) In sugar		12.2

E) *Calasiao*

1) Effective area of survey	ha.	100.2
a) In rice		60.3
i) 1st crop		57.3
ii) 2nd crop		3.0
b) In maize, 2nd crop		2.6
c) In sugar		36.3
e) In vegetables and fruits		1.0

F) *Naic*

1) Effective area of survey	ha.	283.8
a) In rice, 1st crop		253.5
b) In maize, 1st crop		0.9
c) In sugar		29.4

G) *Aparri*

1) Effective area of survey	ha.	190.0
a) In rice, 1st crop		189.0
e) In vegetables and fruits		1.0

H) *Bay*

1) Effective area of survey	ha.	337.0
a) In rice, 1st crop		298.2
b) In maize, 1st crop		13.8
d) In zacate		11.4
e) In vegetables and fruits		13.6

I) *All surveys*

1) Effective area of the surveys	ha.	2086.3
a) In rice		1915.9
i) 1st crop		1800.8
ii) 2nd crop		115.1
b) In maize		59.0
i) 1st crop		56.4
ii) 2nd crop		2.6
c) In sugar		82.2
d) In zacate		11.4
e) In vegetables and fruits		17.8
f) All 1st and continuous crops		1968.6
g) All 2nd crops		117.7
2) Percentage of effective area in:		
a) Rice		91.8
b) Maize		2.8
c) Sugar		3.9
d) Zacate		0.6
e) Vegetables and fruits		0.9

III. TENURE

A) *Tigbauan.*—Not reported.
B) *San Miguel.*—Not reported.
C) *Santa Rosa*

1) Number of tenants in survey	81
2) Length of tenure	
a) Average for each tenant ... yrs.	14.8
b) Maximum for one tenant	40.0
c) Minimum for one tenant	1.0
d) Percentage of tenants of less than 5 years	30.8
2) Poly-tenantry[3]	
a) Number of tenants with 2 tenancies	16.
b) Number of tenants with 3 tenancies	5.
c) Number of tenants with 4 tenancies	3.
d) Percentage of tenants under poly-tenantry	29.6

D) *Hagonoy*

1) Number of tenants in survey	138.
2) Length of tenure	
a) Average for each tenant ... yrs.	9.3
b) Maximum for one tenant	40.0
c) Minimum for one tenant	1.0
d) Percentage of tenants of less than 5 years	50.6
3) Poly-tenantry	
a) Number of tenants with 2 tenancies	33.
b) Number of tenants with 3 tenancies	1.
c) Number of tenants with 4 tenancies	1.
d) Percentage of tenants under poly-tenantry	25.4
4) Reasons for leaving former tenancies	
a) Controversy with landlord	48.
b) Area too limited	5.
c) Tenancy abolished	32.
d) Lack of work animals	2.
e) Poor soil	2.
g) Other reasons	6.

E) *Calasiao*

1) Number of tenants in survey	99
2) Length of tenure	
a) Average for each tenant ... yrs.	7.3
b) Maximum for one tenant	20.0
c) Minimum for one tenant	0.7
d) Percentage of tenants of less than 5 years	59.6
3) Poly-tenantry	
a) Number of tenants with 2 tenancies	19.
b) Number of tenants with 3 tenancies	9.
c) Number of tenants with 4 tenancies	2.
d) Percentage of tenants under poly-tenantry	30.3
4) Reasons for leaving former tenancies	
a) Controversy with landlord	6.
c) Tenancy abolished	8.
e) Poor soil	6.
f) Parcel too far from residence	15.
g) Other reasons	12.

F) *Naic*

1) Number of tenants in survey	151.
2) Length of tenure	
a) Average for each tenant ... yrs.	3.8
b) Maximum for one tenant	12.0
c) Minimum for one tenant	0.7
d) Percentage of tenants of less than 5 years	89.4
3) Poly-tenantry	
a) Number of tenants with 2 tenancies	6.
b) Number of tenants with 3 tenancies	1.
c) Number of tenants with 4 tenancies	1.
d) Percentage of tenants under poly-tenantry	5.3
4) Reasons for leaving former tenancies	
a) Controversy with landlord	72.
d) Lack of work animals	17.
e) Poor soil	9.
g) Other reasons	19.

[3] Poly-tenantry is here used to cover case of tenants who are serving more than one landlord.

G) *Aparri*

1) Number of tenants in survey ... 111
2) Length of tenure
   a) Average for each tenant ... yrs. 6.1
   b) Maximum for one tenant ... 50.0
   c) Minimum for one tenant ... 1.0
   d) Percentage of tenants of less than 5 years ... 73.0
3) Poly-tenantry
   a) Number of tenants with 2 tenancies ... 5.
   b) Number of tenants with 3 tenancies ... 2.
   d) Percentage of tenants under poly-tenantry ... 6.3
4) Reasons for leaving former tenancies
   a) Tenancy abolished ... 4.
   b) Poor soil ... 1.
   c) Other reasons ... 7.

H) *Bay*

1) Number of tenants in survey ... 160
2) Length of tenure
   a) Average for each tenant ... yrs. 3.8
   b) Maximum for one tenant ... 25.0
   c) Minimum for one tenant ... 1.0
   d) Percentage of tenants of less than 5 years ... 88.7
3) Poly-tenantry
   a) Number of tenants with 2 tenancies ... 29.
   d) Percentage of tenants under poly-tenantry ... 18.1
4) Reasons for leaving former tenancies
   b) Area too limited ... 85.
   c) Tenancy abolished ... 19.
   d) Lack of work animals ... 3.
   e) Poor soil ... 4.
   g) Other reasons ... 8.

I) *All surveys reported*

1) Number of tenants in the surveys ... 740.
2) Length of tenure
   a) Average for each tenant ... yrs. 6.8
   b) Maximum for one tenant ... 50.0
   c) Minimum for one tenant ... 0.7
   d) Percentage of tenants of less than 5 years ... 69.2
3) Poly-tenantry
   a) Number of tenants with 2 tenancies ... 108.
   b) Number of tenants with 3 tenancies ... 18.
   c) Number of tenants with 4 tenancies ... 7.
   d) Percentage of tenants under poly-tenantry ... 18.0
4) Reasons for leaving former tenancies (390 reporting)
   a) Controversy with landlord ... 126.
   b) Area too limited ... 90.
   c) Tenancy abolished ... 63.
   d) Lack of work animals ... 22.
   e) Poor soil ... 22.
   f) Parcel too far from residence ... 15.
   g) Other reasons ... 52.

IV. CONTRACTS FOR LOWLAND RICE

A) *Aparri Type*

1) *Land:* Furnished by landlord
2) *Labor*
   a) Pre-harvest by tenant
   b) Harvest by tenant and third parties
   c) Post-harvest by tenant
3) *Capital*
   a) Implements by tenant
   b) Work animal by tenant
   c) Seed by tenant
4) *Division*
   a) *Gross product*
      i) 20 per cent to harvesters
      ii) 80 per cent to net product
   b) *Net product*
      i) 33⅓ per cent to landlord
      ii) 66⅔ per cent to tenant

5) *Application*
    a) Aparri, 105 tenancies

B) *Bay Type*
    1) *Land:* Furnished by landlord
    2) *Labor*
        a) Pre-harvest by tenant
        b) Harvest by tenant and third parties
        c) Post-harvest by tenant
    3) *Capital*
        a) Implements by tenant
        b) Work animals by landlord
        c) Seed by landlord
    4) *Division*
        a) *Gross product*
            i) 10 to 17 per cent to harvesters
            ii) Seed returned to landlord
            iii) 83 to 90 per cent less seed to net product
        b) *Net product*
            i) 50 per cent to landlord
            ii) 50 per cent to tenant
    5) *Application*
        a) Bay, 86 tenancies

C) *Bay Subtype 1*
    1) *Land:* Furnished by landlord
    2) *Labor*
        a) Pre-harvest by tenant
        b) Harvest by tenant and third parties
        c) Post-harvest by tenant
    3) *Capital*
        a) Implements by tenant
        b) Work animals by landlord
        c) Seed by landlord
    4) *Division*
        a) *Gross product*
            i) 10 to 17 per cent to harvesters
            ii) Seed returned to landlord
            iii) 83 to 90 per cent less seed to net product
        b) *Net product*
            i) $66\frac{2}{3}$ per cent to landlord
            ii) $33\frac{1}{2}$ per cent to tenant
    5) *Application*
        a) Bay, 11 tenancies
        b) Tigbauan, 3 tenancies

D) *Bay Subtype 2*
    1) *Land:* Furnished by landlord
    2) *Labor*
        a) Pre-harvest by tenant
        b) Harvest by tenant and third parties
        c) Post-harvest by tenant
    3) *Capital*
        a) Implements by tenant
        b) Work animals by landlord
        c) Seed by landlord
    4) *Division*
        a) *Gross product*
            i) 20 per cent to harvesters
            ii) Seed returned to landlord
            iii) 80 per cent less seed to net product
        b) *Net product*
            i) 60 per cent to landlord
            ii) 40 per cent to tenant
    5) *Application*
        a) Bay, 10 tenancies

E) *Calasiao Type*
    1) *Land:* Furnished by landlord
    2) *Labor*
        a) Pre-harvest by tenant
        b) Harvest by tenant and third parties
        c) Post-harvest by tenant

3) *Capital*
   a) Implements by tenant
   b) Work animals by tenant
   c) Seed by landlord
4) *Division*
   a) *Gross product*
      i) 10 to 17 per cent to harvesters
      ii) 83 to 90 per cent to net product
   b) *Net product*
      i) 50 per cent to landlord
      ii) 50 per cent to tenant
5) *Application*
   a) Calasiao, 71 tenancies

F) Hagonoy Type

1) *Land:* Furnished by landlord
2) *Labor*
   a) Pre-harvest by tenant
   b) Harvest by tenant and third parties
   c) Post-harvest by tenant
3) *Capital*
   a) Implements by tenant
   b) Work animals by tenant
   c) Seed by landlord
4) *Division*
   a) *Gross product*
      i) 10 to 17 per cent to harvesters
      ii) Seed returned to landlord
      iii) 83 to 90 per cent less seed to net product
   b) *Net product*
      i) 50 per cent to landlord
      ii) 50 per cent to tenant
5) *Application*
   a) Hagonoy, 136 tenancies
   b) Tigbauan, 37 tenancies
   c) Bay, 8 tenancies

G) Naic Type

1) *Land:* Furnished by landlord, but 4 to 8 cavans of palay for each cavan of seed planted required as special contribution or *buis* to assist the landlord in paying his installment on purchase of land.
2) *Labor*
   a) Pre-harvest, except transplanting, by tenant
   b) Transplanting by tenant and third parties
   c) Harvest by tenant and third parties
   d) Post-harvest by tenant
3) *Capital*
   a) Implements by tenant
   b) Work animals by tenant
   c) Seed by landlord
4) *Division*
   a) *Gross product*
      i) Variable per cent to harvesters
      ii) *Buis* to landlord
      iii) Balance to net product
   b) *Net product*
      i) 50 per cent to landlord
      ii) 50 per cent to tenant
5) *Application*
   a) Naic, 139 tenancies

H) San Miguel Type

1) *Land:* Furnished by landlord
2) *Labor*
   a) Pre-harvest by tenant
   b) Harvest by tenant and group labor
   c) Post-harvest by tenant
3) *Capital*
   a) Implements by tenant
   b) Work animals by tenant
   c) Seed by landlord

4) *Division*
   a) *Gross product*
      i) Seed returned to landlord
      ii) Balance to net product
   b) *Net product*
      i) 40 per cent to landlord
      ii) 60 per cent to tenant
5) *Application*
   a) San Miguel, 40 tenancies

I) *Santa Rosa Type*
1) *Land:* Furnished by landlord, but tenant required to pay a special cash contribution or, *canon,* of ₱10 per annum per hectare to assist the landlord in paying his installments on the purchase of the land.
2) *Labor*
   a) Pre-harvest, except transplanting, by tenant
   b) Transplanting by tenant and third parties
   c) Harvest by tenant and third parties
   d) Post-harvest by tenant and third parties
3) *Capital*
   a) Implements by tenant
   b) Work animals by tenant
   c) Seed by landlord
4) *Division*
   a) *Gross product*
      i) 10 to 25 per cent to transplanters and harvesters.
      ii) Seed returned to landlord
      iii) 75 to 90 per cent less seed to net product
   b) *Net product*
      i) 50 per cent to landlord
      ii) 50 per cent to tenant
5) *Application*
   a) Santa Rosa, 59 tenancies

J) *Santa Rosa Subtype 1*
1) *Land:* Furnished by landlord but tenant required to pay a special cash contribution, or *canon,* of ₱10 per annum per hectare to assists the landlord in paying his installments on the purchase of the land
2) *Labor*
   a) Pre-harvest, except transplanting by tenant
   b) Transplanting by tenant and third parties
   c) Harvest by tenant and third parties
   d) Post-harvest by tenant and third parties
3) *Capital*
   a) Implements by helper
   b) Work animals by tenant
   c) Seed by landlord
4) *Division*
   a) *Gross product*
      i) 10 to 25 per cent to landlord
      ii) Seed returned to landlord
      iii) 75 to 90 per cent less seed to net product
   b) *Net product*
      a) 50 per cent to landlord
      b) 25 per cent to tenant
      c) 25 per cent to "helper"
5) *Application*
   a) Santa Rosa, 19 tenancies

K) *Tigbauan Type*
1) *Land:* Furnished by landlord
2) *Labor*
   a) Pre-harvest by tenant
   b) Harvest by tenant and third parties
   c) Post-harvest by tenant
3) *Capital*
   a) Implements by tenant
   b) Work animals by tenant
   c) Seed by landlord

4) *Division*
   a) *Gross product*
      i) 10 to 17 per cent to harvesters
      ii) Seed returned to landlord
      iii) 83 to 90 per cent less seed to net product
   b) *Net product*
      i) 33⅓ per cent to landlord
      ii) 66⅔ per cent to tenant
5) *Application*
   a) Tigbauan, 10 tenancies
   b) Bay, 7 tenancies

V. DISTRIBUTION OF TYPES OF CONTRACTS

A) *Tigbauan*	
1) Number of tenants in survey	50
2) Number of tenants under:	
c) Bay Subtype 1	3
f) Hagonoy Type	37
k) Tigbauan Type	10
B) *San Miguel*	
1) Number of tenants in survey	40
2) Number of tenants under:	
h) San Miguel Type	40
C) *Santa Rosa*	
1) Number of tenants in survey	81
2) Number of tenants under:	
i) Santa Rosa Type	59
j) Santa Rosa Subtype 1	19
l) Special contracts[4]	3
D) *Hagonoy*	
1) Number of tenants in survey	138
2) Number of tenants under:	
f) Hagonoy Type	136
e) Special contracts	2
E) *Calasiao*	
1) Number of tenants in survey	99
2) Number of tenants under:	
e) Calasiao Type	71
l) Special contracts	28
F) *Naic*	
1) Number of tenants in survey	151
2) Number of tenants under:	
g) Naic Type	139
l) Special contracts	12
G) *Aparri*	
1) Number of tenants in survey	111
2) Number of tenants under:	
a) Aparri Type	105
l) Special contracts	6
H) *Bay*	
1) Number of tenants in survey	160
2) Number of tenants under:	
b) Bay Type	86
c) Bay Suptype 1	11
d) Bay Subtype 2	10
f) Hagonoy Type	8
k) Tigbauan Type	7
l) Special contracts	38

[4] Special contracts are those which because of their infrequent application have not been studied and listed. No contract was listed as a type or subtype unless it applied to 10 or more tenancies. This designation includes the few cases in which neither the tenant nor the landlord would divulge the terms of contract.

I) *All surveys*		
1) Number of tenants in the surveys		830
2) Number of tenants under:		
a) Aparri Type		105
b) Bay Type		86
c) Bay Subtype 1		14
d) Bay Subtype 2		10
e) Calasiao Type		71
f) Hagonoy Type		181
g) Naic Type		139
h) San Miguel Type		40
i) Santa Rosa Type		59
j) Santa Rosa Subtype 1		19
k) Tigbauan Type		17
l) Special contracts		89

VI. SUPERVISION OF LANDLORD

A) *Tigbauan*		
1) Gross area of survey	ha.	129.4
2) Percetange of area under:		
a) Complete supervision[5]		71
b) Intermittent supervision[6]		16
c) Ineffective supervision[7]		13
B) *San Miguel*		
1) Gross area of survey	ha.	114.5
2) Percentage of area under:		
a) Complete supervision		100
C) *Santa Rosa*		
1) Gross area of survey	ha.	380.3
2) Percentage of area under:		
a) Complete supervision		74
b) Intermittent supervision		13
c) Ineffective supervision		13
D) *Hagonoy*		
1) Gross area of survey	ha.	439
2) Percentage of area under:		
a) Complete supervision		34
b) Intermittent supervision		44
c) Ineffective supervision		22
E) *Calasiao*		
1) Gross area of survey	ha.	97
2) Percentage of area under:		
a) Complete supervision		19
b) Intermittent supervision		17
c) Ineffective supervision		64
F) *Naic*		
1) Gross area of survey	ha.	288
2) Percentage of area under:		
a) Complete supervision		32
b) Intermittent supervision		65
c) Ineffective supervision		3
G) *Aparri*		
1) Gross area of survey	ha.	190
2) Percentage of area under:		
b) Intermittent supervision		2
c) Ineffective supervision		98
H) *Bay*		
1) Gross area of survey	ha.	337
2) Percentage of area under:		
a) Complete supervision		29
b) Intermittent supervision		64
c) Ineffective supervision		7

[5] Dates and methods for all farm processes dictated by the landlord or his agent.
[6] Not more than five inspections annually by the landlord or his agent.
[7] Landlord or agent appeared only for the purpose of checking the harvest and verifying his share.

I) *All surveys*

- 1) Gross area of survey — ha. 1975.2
- 2) Percentage of area under:
  - a) Complete supervision — 43
  - b) Intermittent supervision — 35
  - c) Ineffective supervision — 22

VII. TENANTS' FARM LABOR TIME

A) *Tigbauan*

- 1) Number of tenants in survey — 50
- 2) Farm labor time per annum — hrs. 55,700
  - a) Average for each tenant (50) — 1,114
  - b) Average per hectare (129.4) — 430
- 3) Division of labor time
  - a) Preparation of land — 15,900
    - i) Average for each tenant (50) — 318
    - ii) Average per hectare (129.4) — 123
  - b) Planting and transplanting — 5,200
    - i) Average for each tenant (50) — 104
    - ii) Average per hectare (129.4) — 40
  - c) Cultivation — 15,600
    - i) Average for each tenant (50) — 312
    - ii) Average per hectare (129.4) — 121
  - d) Harvesting — 17,300
    - i) Average for each tenant (50) — 346
    - ii) Average per hectare (129.4) — 134
  - e) General labor — 1,700
    - i) Average for each tenant (50) — 34
    - ii) Average per hectare (129.4) — 13
- 4) Percentage of labor time
  - a) Preparation of land — 29
  - b) Planting and transplanting — 9
  - c) Cultivation — 28
  - d) Harvesting — 31
  - e) General labor — 3

B) *San Miguel*—Not reported

C) *Santa Rosa*

- 1) Number of tenants in survey — 81
- 2) Farm labor time per annum — hrs 95,580
  - a) Average for each tenant (81) — 1,180
  - b) Average per hectare (380.3) — 251
- 3) Division of labor time
  - a) Preparation of land — 49,977
    - i) Average for each tenant (81) — 617
    - ii) Average per hectare (380.3) — 131
  - b) Planting and transplanting — 1,377
    - i) Average for each tenant (81) — 17
    - ii) Average per hectare (380.3) — 4
  - c) Cultivation — 30,051
    - i) Average for each tenant (81) — 371
    - ii) Average per hectare (380.3) — 79
  - d) Harvesting — 14,175
    - i) Average for each tenant (81) — 175
    - ii) Average per hectare (380.3) — 37
- 4) Percentage of labor time
  - a) Preparation of land — 52
  - b) Planting and transplanting — 2
  - c) Cultivation — 31
  - d) Harvesting — 15

D) *Hagonoy*

- 1) Number of tenants in survey — 138
- 2) Farm labor time per annum — hrs. 89,148
  - a) Average for each tenant (138) — 646
  - b) Average per hectare (439) — 203
- 3) Division of labor time
  - a) Preparation of land — 42,780
    - i) Average for each tenant (138) — 310
    - ii) Average per hectare (439) — 97

b) Planting and transplanting.... 7,176
 i) Average for each tenant (138).... 52
 ii) Average per hectare (439).... 16
C) Cultivation.... 1,794
 i) Average for each tenant (138).... 13
 ii) Average per hectare (439).... 4
d) Harvesting.... 27,600
 i) Average for each tenant (138).... 200
 ii) Average per hectare (439).... 63
e) General labor.... 9,798
 i) Average for each tenant (138).... 71
 ii) Average per hectare (439).... 22
4) Percentage of labor time
 a) Preparation of land.... 48
 b) Planting and transplanting.... 8
 c) Cultivation.... 2
 d) Harvesting.... 31
 e) General labor.... 11

E) *Calasiao*
1) Number of tenants in survey.... 99
2) Farm labor time per annum.... hrs. 42,481
 a) Average for each tenant (99).... 429
 b) Average per hectare (97).... 438
3) Division of labor time
 a) Preparation of land.... 10,593
  i) Average for each tenant (99).... 107
  ii) Average per hectare (97).... 109
 b) Planting and transplanting.... 5,445
  i) Average for each tenant (99).... 55
  ii) Average per hectare (97).... 56
 c) Cultivation.... 901
  i) Average for each tenant (99).... 9
  ii) Average per hectare (97).... 9
 d) Harvesting.... 18,810
  i) Average for each tenant (99).... 190
  ii) Average per hectare (97).... 194
 e) General labor.... 6,732
  i) Average for each tenant (99).... 68
  ii) Average per hectare (97).... 69
4) Percentage of labor time
 a) Preparation of land.... 25
 b) Planting and transplanting.... 13
 c) Cultivation.... 2
 d) Harvesting.... 44
 e) General labor.... 16

F) *Naic*
1) Number of tenants in survey.... 151
2) Farm labor time per annum.... hrs. 92,865
 a) Average for each tenant (151).... 615
 b) Average per hectare (288).... 322
3) Division of labor time
 a) Preparation of land.... 44,394
  i) Average for each tenant (151).... 294
  ii) Average per hectare (288).... 154
 b) Planting and transplanting.... 1,661
  i) Average for each tenant (151).... 11
  ii) Average per hectare (288).... 6
 c) Cultivation.... 15,402
  i) Average for each tenant (151).... 102
  ii) Average per hectare (288).... 53
 d) Harvesting.... 11,174
  i) Average for each tenant (151).... 74
  ii) Average per hectare (288).... 39
 e) General labor.... 20,234
  i) Average for each tenant (151).... 134
  ii) Average per hectare (288).... 70
4) Percentage of labor time
 a) Preparation of land.... 48
 b) Planting and transplanting.... 2

c) Cultivation 16
d) Harvesting 12
e) General labor 22

G) *Aparri*

1) Number of tenants in survey 111
2) Farm labor time per annum .... hrs. 55,389
   a) Average for each tenant (111) 499
   b) Average per hectare (190) 292
3) Division of labor time
   a) Preparation of land 9,657
      i) Average for each tenant (111) 87
      ii) Average per hectare (190) 51
   b) Planting and transplanting 8,658
      i) Average for each tenant (111) 78
      ii) Average per hectare (190) 46
   d) Harvesting 29,859
      i) Average for each tenant (111) 269
      ii) Average per hectare (190) 157
   e) General labor 7,215
      i) Average for each tenant (111) 65
      ii) Average per hectare (190) 38
4) Percentage of labor time
   a) Preparation of land 18
   b) Planting and transplanting 16
   d) Harvesting 53
   e) General labor 13

H) *Bay*

1) Number of tenants in survey 160
2) Farm labor time per annum .... hrs. 125,933
   a) Average for each tenant (160) 787
   b) Average per hectare (337) 374
3) Division of labor time
   a) Preparation of land 43,840
      i) Average for each tenant (160) 274
      ii) Average per hectare (337) 130
   b) Planting and transplanting 10,220
      i) Average for each tenant (160) 64
      ii) Average per hectare (337) 30
   c) Cultivation 9,600
      i) Average for each tenant (160) 60
      ii) Average per hectare (337) 29
   d) Harvesting 50,113
      i) Average for each tenant (160) 314
      ii) Average per hectare (337) 149
   e) General labor 12,160
      i) Average for each tenant (160) 76
      ii) Average per hectare (337) 36
4) Percentage of labor time
   a) Preparation of land 35
   b) Planting and transplanting 8
   c) Cultivation 8
   d) Harvesting 40
   e) General labor 9

I) *All surveys reported*

1) Number of tenants in the surveys 790
2) Farm labor time per annum .... hrs. 557,096
   a) Average for each tenant (790) 705
   b) Average per hectare (1860.7) 299
3) Division of labor time
   a) Preparation of land 217,141
      i) Average for each tenant (790) 275
      ii) Average per hectare (1860.7) 116
   b) Planting and transplanting 39,737
      i) Average for each tenant (790) 50
      ii) Average per hectare (1860.7) 21
   c) Cultivation 73,348
      i) Average for each tenant (790) 93
      ii) Average per hectare (1860.7) 39

d) Harvesting	169,031
i) Average for each tenant (790)	214
ii) Average per hectare (1860.7)	91
e) General labor	57,839
i) Average for each tenant (790)	73
ii) Average per hectare (1860.7)	31
4) Percentage of labor time	
a) Preparation of land	39
b) Planting and transplanting	7
c) Cultivation	13
d) Harvesting	30
e) General labor	11

VIII. ANIMAL LABOR

A) *Tigbauan.*—Not reported.
B) *San Miguel.*—Not reported.

C) *Santa Rosa*	
1) Number of work animals in survey	211
2) Annual animal labor time for survey	hrs. 49,998
a) Average for each animal (211)	237
b) Average for each tenancy (81)	617
c) Average per hectare (380.3)	131
D) *Hagonoy*	
1) Number of work animals in survey	240
2) Annual animal labor time for survey	hrs. 43,520
a) Average for each animal (240)	181
b) Average for each tenancy (138)	315
c) Average per hectare (439)	99
E) *Calasiao*	
1) Number of work animals in survey	101
2) Annual animal labor time for survey	hrs. 23,634
a) Average for each animal (101)	234
b) Average for each tenancy (99)	239
c) Average per hectare (97)	244
F) *Naic*	
1) Number of work animals in survey	192
2) Annual animal labor time for survey	hrs. 61,146
a) Average for each animal (192)	318
b) Average for each tenancy (151)	405
c) Average per hectare (288)	212
G) *Aparri*	
1) Number of work animals in survey	191
2) Annual animal labor time for survey	hrs. 27‘367
a) Average for each animal (191)	143
b) Average for each tenancy (111)	247
c) Average per hectare (190)	144

H) *Bay.*—Not reported

I) *All surveys reported*	
1) Number of work animals in survey	935
2) Annual animal labor time for survey	hrs. 205,665
a) Average for each animal (935)	220
b) Average for each tenancy (580)	355
c) Average per hectare (1394.3)	148

IX. TENANTS' FARM INVESTMENT

A) *Tigbauan.*—Not reported.
B) *San Miguel.*—Not reported.

C) *Santa Rosa*	
1) Number of tenants	81
2) Number owned of:	
a) Dwellings, including yards	81
d) Work animals	211
i) Average for each tenant (81)	2.6
ii) Average per hectare (380.3)	.6

3) Percentage of tenants owning:	
a) Dwellings, including yards (81)	100
c) Implements, including vehicles (81)	100
d) Work animals (81)	100
4) Value for survey of:	
a) Dwellings, including yards	₱ 6,542
c) Implements, including vehicles	4,051
d) Work animals	23,210
e) All capital goods	33,803
5) Average value of each:	
a) Dwelling, including yard (81)	81
d) Work animal (211)	110
6) Average value for each tenant of:	
a) Dwellings, including yards (81)	81
c) Implements, including vehicles (81)	50
d) Work animals (81)	286
e) All capital goods (81)	417
7) Average value per hectare of:	
a) Dwellings, including yards (380.3)	17
c) Implements, including vehicles (380.3)	11
d) Work animals (380.3)	61
e) All capital goods (380.3)	89
8) Percentage of total investment in:	
a) Dwellings, including yards	22
c) Implements, including vehicles	12
d) Work animals	66

D) *Hagonoy*

1) Number of tenants	138
2) Number owned of:	
a) Dwellings, including yards	138
b) Farm buildings	8
d) Work animals	240
i) Average for each tenant (138)	1.7
ii) Average per hectare (439)	.5
3) Percentage of tenants owning:	
a) Dwellings, including yards (138)	100
b) Farm buildings (8)	6
c) Implements, including vehicles (138)	100
d) Work animals (138)	100
4) Value for survey of:	
a) Dwellings, including yards	₱ 18,275
b) Farm buildings	1,376
c) Implements, including vehicles	1,405
d) Work animals	28,800
e) All capital goods	49,856
5) Average value of each:	
a) Dwelling, including yard (138)	132
b) Farm building (8)	172
d) Work animal (240)	120
6) Average value for each tenant of:	
a) Dwellings, including yards (138)	132
b) Farm buildings (138)	10
c) Implements, including vehicles (138)	10
d) Work animals (138)	209
e) All capital goods (138)	361
7) Average value per hectare of:	
a) Dwellings, including yards (439)	42
b) Farm buildings (439)	3
c) Implements, including vehicles (439)	3
d) Work animals (439)	66
e) All capital goods (439)	113
8) Percentage of total investment in:	
a) Dwellings, including yards	36
b) Farm buildings	3
c) Implements, including vehicles	3
d) Work animals	58

E) *Calasiao*

1) Number of tenants	99
2) Number owned of:	
a) Dwellings, including yards	94

d) Work animals	101
i) Average for each tenant (99)	1
ii) Average per hectare (97)	1
3) Percentage of tenants owning:	
a) Dwellings, including yards (94)	95
c) Implements, including vehicles (99)	100
d) Work animals (99)	100
4) Value for survey of:	
a) Dwellings, including yards	₱ 3,300
c) Implements, including vehicles	6,091
d) Work animals	12,120
e) All capital goods	21,511
5) Average value of each:	
a) Dwelling, including yard (94)	35
d) Work animal (101)	120
6) Average value for each tenant of:	
a) Dwellings, including yards (99)	33
c) Implements, including vehicles (99)	62
d) Work animals (99)	122
e) All capital goods (99)	217
7) Average value per hectare of:	
a) Dwellings, including yards (97)	34
c) Implements, including vehicles (97)	63
d) Work animals (97)	125
e) All capital goods (97)	222
8) Percentage of total investment in:	
a) Dwellings, including yards	15
c) Implements, including vehicles	29
d) Work animals	56

E) *Naic*

1) Number of tenants	151
2) Number owned of:	
a) Dwellings, including yards	146
d) Work animals	192
i) Average for each tenant (151)	1.3
ii) Average per hectare (288)	.7
3) Percentage of tenants owning:	
a) Dwellings, including yards (146)	97
c) Implements, including vehicles (151)	100
d) Work animals (151)	100
4) Value for survey of:	
a) Dwellings, including yards	₱ 23,432
c) Implements, including vehicles	2,641
d) Work animals	21,120
e) All capital goods	47,193
5) Average value of each:	
a) Dwelling, including yard (146)	160
d) Work animal (192)	110
6) Average value for each tenant of	
a) Dwellings, including yards (151)	154
c) Implements, including vehicles (151)	17
d) Work animals (151)	140
e) All capital goods (151)	311
7) Average value per hectare of:	
a) Dwellings, including yards (288)	81
c) Implements, including vehicles (288)	9
d) Work animals (288)	73
e) All capital goods (288)	163
8) Percentage of total investment in:	
a) Dwellings, including yards	50
c) Implements, including vehicles	6
d) Work animals	44

G) *Aparri*

1) Number of tenants	111
2) Number owned of:	
a) Dwellings, including yards	111
b) Farm buildings	44
d) Work animals	191
i) Average for each tenant (111)	1.7
ii) Average per hectare (190)	1.

3) Percentage of tenants owning:
   a) Dwellings, including yards (111) 100
   b) Farm buildings (44) 40
   c) Implements, including vehicles (111) 100
   d) Work animals (104) 94
4) Value for survey of:
   a) Dwellings, including yards ..... ₱ 17,903
   b) Farm buildings 1,310
   c) Implements, including vehicles 1,700
   d) Work animals 26,740
   e) All capital goods 47,653
5) Average value of each:
   a) Dwelling, including yard (111) 161
   b) Farm building (44) 30
   d) Work animal (191) 140
6) Average value for each tenant of:
   a) Dwellings, including yards (111) 161
   b) Farm buildings (111) 12
   c) Implements, including vehicles (111) 15
   d) Work animals (111) 241
   e) All capital goods (111) 429
7) Average value per hectare of:
   a) Dwellings, including yards (190) 94
   b) Farm buildings (190) 7
   c) Implements, including vehicles (190) 9
   d) Work animals (190) 140
   e) All capital goods (190) 250
8) Percentage of total investment in:
   a) Dwellings, including yards 38
   b) Farm buildings 3
   c) Implements, including vehicles 3
   d) Work animals 56

H) *Bay.*—Not reported.

I) *All surveys reported*
1) Number of tenants 580
2) Number owned of:
   a) Dwellings, including yards 570
   b) Farm buildings 52
   d) Work animals 935
      i) Average for each tenant (580) 1.6
      ii) Average per hectare (1394.3) 7
3) Percentage of tenants owning:
   a) Dwellings, including yards 98
   b) Farm buildings 9
   c) Implements, including vehicles 100
   d) Work animals 99
4) Value for survey of:
   a) Dwellings, including yards ..... ₱ 69,452
   b) Farm buildings 2,686
   c) Implements, including vehicles 15,888
   d) Work animals 111,990
   e) All capital goods 200,016
5) Average value of each:
   a) Dwellings, including yard (570) 122
   b) Farm building (52) 52
   d) Work animal (935) 120
6) Average value for each tenant of:
   a) Dwellings, including yards (580) 120
   b) Farm building (580) 5
   c) Implements, including vehicles (580) 27
   d) Work animals (580) 193
   e) All capital goods (580) 345
7) Average value per hectare of:
   a) Dwellings, including yards (1394.3) 50
   b) Farm buildings (1394.3) 2
   c) Implements, including vehicles (1394.3) 11
   d) Work animals (1394.3) 80
   e) All capital goods (1394.3) 143

8) Percentage of total investment of:
   a) Dwellings, including yards 35
   b) Farm buildings 1
   c) Implements, including vehicles 8
   d) Work animals 56

X. TENANTS' FARM INCOME

A) *Tigbauan*
1) Number of tenants in survey 50
2) Income per annum .... ₱ 8,928
   a) Average for each tenant of survey (50) 179
   b) Average per hectare (129.4) 69

B) *San Miguel.*—Not reported.

C) *Santa Rosa*
1) Number of tenants in survey 81
2) Income per annum .... ₱ 26,961
   a) Average for each tenant of survey (81) 333
   b) Average per hectare (380.3) 71

D) *Hagonoy*
1) Number of tenants in survey 138
2) Income per annum .... ₱ 26,889
   a) Average for each tenant of survey (138) 195
   b) Average per hectare (439) 61

E) *Calasiao*
1) Number of tenants in survey 99
2) Income per annum .... ₱ 10,030
   a) Average for each tenant of survey (99) 101
   b) Average per hectare (97) 103

F) *Naic*
1) Number of tenants in survey 151
2) Income per annum .... ₱ 32,359
   a) Average for each tenant of survey (151) 214
   b) Average per hectare (288) 112

G) *Aparri*
1) Number of tenants in survey 111
2) Income per annum .... ₱ 20,382
   a) Average for each tenant of survey (111) 184
   b) Average per hectare (190) 107

H) *Bay*
1) Number of tenants in survey 160
2) Income per annum .... ₱ 23,510
   a) Average for each tenant of survey (160) 148
   b) Average per hectare (337) 70

I) *All surveys reported*
1) Number of tenants in the surveys 790
2) Income per annum .... ₱ 149,059
   a) Average for each tenant (790) 189
   b) Average per hectare (1860.7) 80

XI. SECONDARY OCCUPATIONS

A) *Tigbauan.*—Not reported.
B) *San Miguel.*—Not reported.
C) *Santa Rosa*
1) Number of tenants in survey 81
   a) Number engaged in secondary occupations 67
   b) Percentage of tenants so engaged 83
2) Occupations
   c) Carpenters 13
   f) Drivers 22
   h) General laborers 36
   i) Merchants 8
   j) Tailors 8
   k) All occupations[3] 87

[3] Several tenants were engaged in two or three secondary occupations.

3) Time per annum spent in secondary occupations	hrs. 43,821
a) Average for each occupation (87)	504
b) Average for each tenant so engaged (67)	654
c) Average for each tenant of survey (81)	541
d) Average per hectare (380.3)	115
4) Income per annum from secondary occupations	₱ 9,640
a) Average for each occupations (87)	111
b) Average for each tenant so engaged (67)	144
c) Average for each tenant of survey (81)	119
d) Average per hectare (380.3)	25

D) *Hagonoy*

1) Number of tenants in survey	138
a) Number engaged in secondary occupations	83
b) Percentage of tenants so engaged	60
2) Occupations	
c) Carpenters	8
f) Drivers	3
g) Fishermen	12
h) General laborers	43
i) Merchants	17
k) All occupations	83
3) Time per annum spent in secondary occupations	hrs. 38,364
a) Average for each occupation (83)	462
b) Average for each tenant so engaged (83)	462
c) Average for each tenant of survey (138)	278
d) Average per hectare (439)	87
4) Income per annum from secondary occupations	₱ 12,217
a) Average for each occupation (83)	147
b) Average for each tenant so engaged (83)	147
c) Average for each tenant of survey (138)	88
d) Average per hectare (439)	28

E) *Calasiao*

1) Number of tenants in survey	99
a) Number engaged in secondary occupations	99
b) Percentage of tenants so engaged	100
2) Occupations	
a) Basket-weavers	1
b) Blacksmiths	3
c) Carpenters	3
d) Copra-makers	4
f) Drivers	2
g) Fishermen	1
h) General laborers	85
k) All occupations	99
3) Time per annum spent in secondary occupations	hrs. 66,780
a) Average for each occupation (99)	675
b) Average for each tenant so engaged (99)	675
c) Average for each tenant of survey (99)	675
d) Average per hectare (97)	690
4) Income per annum from secondary occupations	₱ 8,340
a) Average for each occupation (99)	84
b) Average for each tenant so engaged (99)	84
c) Average for each tenant of survey (99)	84
d) Average per hectare (97)	86

F) *Naic*

1) Number of tenants in survey	151
a) Number engaged in secondary occupations	121
b) Percentage of tenants so engaged	80
2) Occupations	
f) Drivers	3
g) Fishermen	35
h) General laborers	83
k) All occupations	121
3) Time per annum spent in secondary occupations	hrs. 67,305
a) Average for each occupation (121)	556
b) Average for each tenant so engaged (121)	556
c) Average for each tenant of survey (151)	446
d) Average per hectare (288)	234

4) Income per annum from secondary occupations ₱ 9,615
   a) Average for each occupation (121) 79
   b) Average for each tenant so engaged (121) 79
   c) Average for each tenant of survey (151) 64
   d) Average per hectare (288) 33

G) *Aparri*

1) Number of tenants in survey 111
   a) Number engaged in secondary occupations 103
   b) Percentage of tenants so engaged 93
2) Occupations
   b) Blacksmiths 1
   c) Carpenters 9
   e) Dairymen 5
   h) General laborers 84
   i) Merchants 4
   k) All occupations 103
3) Time per annum spent in secondary occupations hrs. 59,630
   a) Average for each occupation (103) 579
   b) Average for each tenant so engaged (103) 579
   c) Average for each tenant of survey (111) 537
   d) Average per hectare (190) 314
4) Income per annum from secondary occupations ₱ 9,984
   a) Average for each occupation (103) 97
   b) Average for each tenant so engaged (103) 97
   c) Average for each tenant of survey (111) 90
   d) Average per hectare (190) 53

H) *Bay*

1) Number of tenants in survey 160
   a) Number engaged in secondary occupations 114
   b) Percentage of tenants so engaged 71
2) Occupations
   a) Carpenters 17
   b) Drivers 5
   c) Fishermen 22
   d) General laborers 130
   e) Merchants 9
   f) All occupations 183
3) Time per annum spent in secondary occupations hrs. 81,240
   a) Average for each occupation (183) 444
   b) Average for each tenant so engaged (114) 713
   c) Average for each tenant of survey (160) 508
   d) Average per hectare (337) 241
4) Income per annum from secondary occupations ₱ 13,425
   a) Average for each occupation (183) 73
   b) Average for each tenant so engaged (114) 118
   c) Average for each tenant of survey (160) 84
   d) Average per hectare (337) 40

I) *All surveys reported*

1) Number of tenants in survey 740
   a) Number engaged in secondary occupations 587
   b) Percentage of tenants so engaged 79
2) Occupations
   a) Basket-weavers 1
   b) Blacksmiths 4
   c) Carpenters 50
   d) Copra-makers 4
   e) Dairymen 5
   f) Drivers 35
   g) Fishermen 70
   h) General laborers 461
   i) Merchants 38
   j) Tailors 8
   k) All occupations 676
3) Time per annum spent in secondary occupations hrs. 357,140
   a) Average for each occupation (676) 528
   b) Average for each tenant so engaged (587) 608
   c) Average for each tenant of survey (740) 482
   d) Average per hectare (1731.3) 206

4) Income per annum from secondary occupations ₱ 63,221
  a) Average for each occupation (676) 94
  b) Average for each tenant so engaged (587) 108
  c) Average for each tenant of survey (740) 85
  d) Average per hectare (1731.3) 37

XII. HOUSEHOLD INDUSTRIES

A) *Tigbauan.*—Not reported.
B) *San Miguel.*—Not reported
C) *Santa Rosa*

1) Number of tenants in survey	81
2) Number of tenants with households	60
a) Number engaged in household industries	0

D) *Hagonoy*

1) Number of tenants in survey	138
2) Number of tenants with households	128
a) Number engaged in household industries	98
b) Percentage of households so engaged	77
3) Industries	
a) Embroidering	96
j) Weaving	2
k) All industries	98
4) Income per annum from household industries	₱ 11,771
a) Average for each household so engaged (128)	92
b) Average for each tenant of survey (138)	85
c) Average per hectare (439)	27

E) *Calasiao*

1) Number of tenants in survey	99
2) Number of tenants with households	91
a) Number engaged in household industries	63
b) Percentage of households so engaged	69
3) Industries	
c) Hat-making	39
d) Mat-making	21
g) Sack-weaving	1
h) Tailoring	2
k) All industries	63
4) Income per annum from household industries	₱ 2,336
a) Average for each household so engaged (63)	37
b) Average for each tenant of survey (99)	23
c) Average per hectare (97)	24

F) *Naic*

1) Number of tenants in survey	151
2) Number of tenants with households	74
a) Number engaged in household industries	44
b) Percentage of households so engaged	59
3) Industries	
b) Fishing	13
e) Nipa palm thatch-making	5
f) *Patis*-making[9]	21
g) Sack-weaving	2
h) Tailoring	5
k) All industries	44
4) Income per annum from household industries	₱ 3,501
a) Average for each household so engaged (44)	80
b) Average for each tenant of survey (151)	23
c) Average per hectare (288)	12

G) *Aparri*

1) Number of tenants in survey	111
2) Number of tenants with households	102
a) Number engaged in household industries	0

H) *Bay*

1) Number of tenants in survey	160
2) Number of tenants with households	155
a) Number engaged in household industries	131
b) Percentage of households so engaged	85

[9] *Patis* is a sauce made from salted shrimp

3) Industries
 j) Unclassified . . . 131
4) Income per annum from household industries . . . ₱ 8,258
 a) Average for each household so engaged (131) . . . 63
 b) Average for each tenant of survey (160) . . . 52
 c) Average per hectare (337) . . . 24

I) *All surveys reported*
1) Number of tenants in surveys . . . 740
2) Number of tenants with households . . . 610
 a) Number engaged in household industries . . . 336
 b) Percentage of households so engaged . . . 55
3) Industries
 a) Embroidering . . . 96
 b) Fishing . . . 13
 c) Hat-making . . . 39
 d) Mat-making . . . 21
 e) Nipa palm thatch-making . . . 5
 f) *Patis*-making . . . 21
 g) Sack-weaving . . . 3
 h) Tailoring . . . 5
 i) Weaving . . . 2
 j) Unclassified . . . 131
 k) All industries . . . 336
4) Income per annum from household industries . . . ₱ 25,866
 a) Average for each household so engaged (336) . . . 77
 b) Average for each tenant of reporting surveys (740) . . . 35
 c) Average per hectare (1731.3) . . . 15

XIII. LAND OWNERSHIP AMONG TENANTS

A) *Tigbauan.*—Not reported.
B) *San Miguel*—Not reported.
C) *Santa Rosa*
1) Number of tenants in survey . . . 81
 a) Number owning land . . . 4
 b) Percentage owning land . . . 5
2) Area of land owned by tenants . . . ha. 11.2
 a) Average for each owner (4) . . . 2.8
 b) Average for each tenant (81) . . . 0.1

D) *Hagonoy*
1) Number of tenants in survey . . . 138
 a) Number owning land . . . 14
 b) Percentage owning land . . . 10
2) Area of land owned by tenants . . . ha. 30.8
 a) Average for each owner (14) . . . 2.2
 b) Average for each tenant(138) . . . 0.2

E) *Calasiao*
1) Number of tenants in survey . . . 99
 a) Number owning land . . . 90
 b) Percentage owning land . . . 91
2) Area of land owned by tenants . . . ha. 70.4
 a) Average for each owner (90) . . . 0.8
 b) Average for each tenant (99) . . . 0.7

F) *Naic*
1) Number of tenants in survey . . . 151
 a) Number owning land . . . 62
 b) Percentage owning land . . . 41
2) Area of land owned by tenants . . . ha. 58.6
 a) Average for each owner (62) . . . 0.9
 b) Average for each tenant (151) . . . 0.4

G) *Aparri*
1) Number of tenants in survey . . . 111
 a) Number owning land . . . 55
 b) Percentage owning land . . . 50
2) Area of land owned by tenants . . . 21.3
 a) Average for each owner (55) . . .
 b) Average for each tenant (111) . . . 1.1

H) *Bay*

1) Number of tenants in survey		160
a) Number owning land		88
b) Percentage owning land		55
2) Area of land owned by tenants	ha.	102.8
a) Average for each owner (88)		1.2
b) Average for each tenant (160)		0.6

I) *All surveys reported*

1) Number of tenants in the surveys		740
a) Number owning land		313
b) Percentage owning land		42
2) Area of land owned by tenants	ha.	395.1
a) Average for each owner (313)		1.3
b) Average for each tenant (740)		.5

XIV. TENANTS INDEBTEDNESS

A) *Tigbauan*

1) Number of tenants in survey		50
a) Number indebted		6
b) Percentage indebted		12
2) Number of loans		6
3) Amount of all loans	₱	57.50
a) Amount of loans from landlord		57.50
c) Amount of productive loans		57.50
e) Average amount for each indebted tenant (6)		9.58
f) Average amount for each tenant (50)		1.15
g) Average amount per hectare (129.4)		.44

B) *San Miguel*

1) Number of tenants in survey		40
a) Number indebted		40
b) Percentage indebted		100
2) Number of loans		40
3) Amount of all loans	₱	1,370.00
a) Amount of loans from landlord		1,370.00
c) Amount of productive loans		1,370.00
e) Average amount for each indebted tenant (40)		34.25
f) Average amount for each tenant (40)		34.25
g) Average amount per hectare (114.5)		11.97

C) *Santa Rosa*

1) Number of tenants in survey		81
a) Number indebted		48
b) Percentage indebted		59
2) Number of loans		59
3) Amount of all loans	₱	12,925.00
a) Amount of loans from landlord		12,925.00
c) Amount of productive loans		4,975.00
d) Amount of consumptive loans		7,940.00
e) Average amount for each indebted tenant (48)		269.27
f) Average amount for each tenant (81)		159.57
g) Average amount per hectare (380.3)		33.99

D) *Hagonoy*

1) Number of tenants in survey		138
a) Number indebted		60
b) Percentage indebted		43
2) Number of loans		57
3) Amount of all loans	₱	4,869.00
a) Amount of loans from landlord		3,596.00
b) Amount of loans from third parties		1,273.00
c) Amount of productive loans		961.00
d) Amount of consumptive loans		3,908.00
e) Average amount for each indebted tenant (60)		81.15
f) Average amount for each tenant (138)		35.28
g) Average amount per hectare (439)		11.09

E) *Calasiao*

1) Number of tenants in survey		99
a) Number indebted		99
b) Percentage indebted		100

2) Number of loans	192
3) Amount of all loans	₱ 1,263 00
a) Amount of loans from landlord	233 00
b) Amount of loans from third parties	1,030.00
c) Amount of productive loans	128.00
d) Amount of consumptive loans	1,135.00
e) Average amount for each indebted tenant (99)	12 76
f) Average amount for each tenant (99)	12.76
g) Average amount per hectare (97)	13 02
F) Naic	
1) Number of tenants in survey	151
a) Number indebted	151
b) Percentage indebted	100
2) Number of loans	206
3) Amount of all loans	₱ 1,468 00
a) Amount of loans from landlord	406.00
b) Amount of loans from third parties	1,062 00
c) Amount of productive loans	248.00
d) Amount of consumptive loans	1,220.00
e) Average amount for each indebted tenant (151)	9 72
f) Average amount for each tenant (151)	9 72
g) Average amount per hectare (288)	5 10
G) Aparri	
1) Number of tenants in survey	111
a) Number indebted	0
H) Bay	
1) Number of tenants in survey	160
a) Number indebted	29
b) Percentage indebted	19
2) Number of loans	29
3) Amount of all loans	₱ 2,997 50
a) Amount of loans from landlord	2,997 50
c) Amount of productive loans	2,097.50
d) Amount of consumptive loans	900.00
e) Average amount for each indebted tenant (29)	103 36
f) Average amount for each tenant (160)	18 73
g) Average amount per hectare (337)	8 91
I) All surveys reported	
1) Number of tenants in survey	830
a) Number indebted	433
b) Percentage indebted	52
2) Number of loans	589
3) Amount of all loans	₱ 24,950.00
a) Amount of loans from landlord	21,585.00
b) Amount of loans from third parties	3,365.00
c) Amount of productive loans	9,837.00
d) Amount of consumptive loans	15,103.00
e) Average amount for each indebted tenant (433)	57.62
f) Average amount for each tenant (830)	30.01
g) Average amount per hectare (1975 2)	12.63

XV. POPULATION OF TENANCIES

A) Tigbauan	
1) Number of tenants in survey	50
2) Number of tenants with households	47
3) Number of:	
a) Husbands and widowers	47
b) Wives and widows	47
c) Single tenants	3
d) Dependent living children	152
e) Self-supporting children	1
f) Deceased children	101
g) Dependents other than children	16
4) Average number in family[10]	7.0
5) Average number in living family[11]	5.0
6) Average number in household [12]	5.6
7) Population of survey[13]	265
a) Average population for one tenancy (50)	5.3
b) Average population per hectare (129.4)	2 0

[10] The quotient of (3a + 3b + 3c + 3d + 3e + 3f) by (1)
[11] The quotient of (3a + 3b + 3c + 3d + 3e) by (1).
[12] The quotient of (3a + 3b + 3d + 3g) by (2).
[13] The sum of (3a + 3b + 3c + 3d + 3g).

B) *San Miguel*

1) Number of tenants in survey	40
2) Number of tenants with households	33
3) Number of:	
a) Husbands and widowers	33
b) Wives and widows	33
c) Single tenants	7
d) Dependent living children	42
e) Self-supporting children	32
f) Deceased children	26
g) Dependents other than children	8
4) Average number in family	4.3
5) Average number in living family	3.7
6) Average number in household	3.5
7) Population of survey	123
a) Average population for one tenancy (40)	3.0
b) Average population per hectare (114.5)	1 0

C) *Santa Rosa*

1) Number of tenants in survey	81
2) Number of tenants with households	60
3) Number of:	
a) Husbands and widowers	74
b) Wives and widows	74
c) Single tenants	7
d) Dependent living children	203
e) Self-supporting children	80
f) Deceased children	147
g) Dependents other than children	36
4) Average number in family	7.2
5) Average number in living family	5.4
6) Average number in household	6.5
7) Population of survey	394
a) Average population for one tenancy (81)	4 9
b) Average population per hectare (380 3)	1 0

D) *Hagonoy*

1) Number of tenants in survey	138
2) Number of tenants with households	128
3) Number of:	
a) Husbands and widowers	127
b) Wives and widows	121
c) Single tenants	10
d) Dependent living children	362
e) Self-supporting children	139
f) Deceased children	251
g) Dependents other than children	58
4) Average number in family	7.3
5) Average number in living fa mily	5 5
6) Average number in household	5.2
7) Population of survey	678
a) Average population for one tenancy (138)	4.9
b) Average population perhectare (439)	1 5

E) *Calasiao*

1) Number of tenants in survey	99
2) Number of tenants with households	91
3) Number of:	
a) Husbands and widowers	92
b) Wives and widows	92
c) Single tenants	7
d) Dependent living children	241
e) Self-supporting children	31
f) Deceased children	181
g) Dependents other than children	19
4) Average number in family	6.5
5) Average number in living family	4.7
6) Average number in household	4.9
7) Population of survey	451
a) Average population for one tenancy (99)	4.6
b) Average population per hectare (97)	4.7

F)	*Naic*	
	1) Number of tenants in survey	151
	2) Number of tenants with households	74
	3) Number of:	
	a) Husbands and widowers	147
	b) Wives and widows	147
	c) Single tenants	4
	d) Dependent living children	276
	e) Self-supporting children	67
	f) Deceased children	312
	g) Dependents other than children	62
	4) Average number in family	6.3
	5) Average number in living family	4.2
	6) Average number of household	8.5
	7) Population of survey	636
	a) Average population for one tenancy (151)	4.2
	b) Average population per hectare (288)	2.2
G)	*Aparri*	
	1) Number of tenants in survey	111
	2) Number of tenants with households	102
	3) Number of:	
	a) Husbands and widowers	100
	b) Wives and widows	102
	c) Single tenants	7
	d) Dependent living children	174
	e) Self-supporting children	85
	f) Deceased children	205
	g) Dependents other than children	84
	4) Average number in family	6.0
	5) Average number in living family	4.2
	6) Average number in household	4.5
	7) Population of survey	467
	a) Average population for one tenancy (111)	4.2
	b) Average population per hectare (190)	2.5
H)	*Bay*	
	1) Number of tenants in survey	160
	2) Number of tenants with households	155
	3) Number of:	
	a) Husbands and widowers	155
	b) Wives and widows	155
	c) Single tenants	5
	d) Dependent living children	330
	e) Self-supporting children	14
	f) Deceased children	304
	g) Dependents other than children	55
	4) Average number in family	6.0
	5) Average number in living family	4.1
	6) Average number in household	4.5
	7) Population of survey	700
	a) Average population for one tenancy (160)	4.4
	b) Average population per hectare (337)	2.1
I)	*All surveys*	
	1) Number of tenants in the surveys	830
	2) Number of tenants with households	690
	3) Number of:	
	a) Husbands and widowers	775
	b) Wives and widows	771
	c) Single tenants	50
	d) Dependent living children	1,780
	e) Self-supporting children	449
	f) Deceased children	1,527
	g) Dependents other than children	338
	4) Average number in family	6.4
	5) Average number in living family	4.6
	6) Average number in household	5.3
	7) Population of survey	3,714
	a) Average population for one tenancy (830)	4.5
	b) Average population per hectare (1975.2)	1.9

XVI. AGE OF TENANTS

A) *Tigbauan*
1) Number of tenants in survey . . . 50
2) Maximum age reported . . . yrs. 76
3) Minimum age reported . . . 20
4) Average age of tenants . . . 44.7

B) *San Miguel*
1) Number of tenants in survey . . . 40
2) Maximum age reported . . . yrs. 76
3) Minimum age reported . . . 19
4) Average age of tenants . . . 39.2

C) *Santa Rosa*
1) Number of tenants in survey . . . 81
2) Maximum age reported . . . yrs. 58
3) Minimum age reported . . . 17
4) Average age of tenants . . . 37.9

D) *Hagonoy*
1) Number of tenants in survey . . . 138
2) Maximum age reported . . . yrs. 80
3) Minimum age reported . . . 18
4) Average age of tenants . . . 44.4

E) *Calasiao*
1) Number of tenants in survey . . . 99
2) Maximum age reported . . . yrs. 70
3) Minimum are reported . . . 18
4) Average age of tenants . . . 38.1

F) *Naic*
1) Number of tenants in survey . . . 151
2) Maximum age reported . . . yrs. 75
3) Minimum age reported . . . 15
4) Average age of tenants . . . 41

G) *Aparri*
1) Number of tenants in survey . . . 111
2) Maximum age reported . . . yrs. 82
3) Minimum age reported . . . 23
4) Average age of tenants . . . 40.7

H) *Bay*
1) Number of tenants in survey . . . 160
2) Maximum age reported . . . yrs. 90
3) Minimum age reported . . . 17
4) Average age of tenants . . . 40 9

I) *All surveys*
1) Number of tenants in the surveys . . . 830
2) Average maximum age of tenants . . . yrs. 77.5
3) Average minimum age of tenants . . . 18
4) Average age of tenants . . . 41

XVII. SEX AND MARITAL CONDITION OF TENANTS

A) *Tigbauan*
1) Number of tenants in survey . . . 50
2) Male tenants . . . 50
   a) Single . . . 3
   b) Married . . . 47
4) Average age at marriage . . . yrs. 18

B) *San Miguel*
1) Number of tenants in survey . . . 40
2) Male tenants . . . 40
   a) Single . . . 7
   b) Marriage . . . 33
4) Average age at marriage . . . yrs. 21

C) *Santa Rosa*
1) Number of tenants in survey . . . 81
2) Male tenants . . . 81
   a) Single . . . 7
   b) Married . . . 74
4) Average age at marriage . . . yrs. 23

D) *Hagonoy*

1)	Number of tenants in survey	138
2)	Male tenants	137
	a) Single	10
	b) Married	120
	c) Widowered	7
3)	Female tenants	1
	a) Widowed	1
4)	Average age at marriage .yrs.	21

E) *Calasiao*

1)	Number of tenants in survey	99
2)	Male tenants	99
	a) Single	7
	b) Married	92
4)	Average age at marriage .yrs.	25

F) *Naic*

1)	Number of tenants in survey	151
2)	Male tenants	151
	a) Single	4
	b) Married	147
4)	Average age at marriage .yrs.	21

G) *Aparri*

1)	Number of tenants in survey	111
2)	Male tenants	109
	a) Single	7
	b) Married	102
3)	Female tenants	2
	a) Widowed	2
4)	Average age at marriage .yrs.	21

H) *Bay*

1)	Number of tenants in survey	160
2)	Male tenants	160
	a) Single	5
	b) Married	155
4)	Average age at marriage .yrs.	24

I) *All surveys*

1)	Number of tenants in the surveys	830
2)	Male tenants	827
	a) Single	50
	b) Married	770
	c) Widowered	7
3)	Female tenants	3
	a) Widowed	3
4)	Average age at marriage .yrs.	22

XVIII. INTERMARRIAGE AMONG TENANTS

A) *Tigbauan.*—Not reported.
B) *San Miguel.*—Not reported.
C) *Santa Rosa*

1)	Percentage of husbands and wives from:	
	a) The same barrio	74
	b) The same municipality	74
	c) The same province	74

D) *Hagonoy*

1)	Percentage of husbands and wives from:	
	a) The same barrio	51
	b) The same municipality	84
	c) The same province	96

E) *Calasiao*

1)	Percentage of husbands and wives from:	
	a) The same barrio	66
	b) The same municipality	82
	c) The same province	100

F) *Naic*
1) Percentage of husbands and wives from:
a) The same barrio 48
b) The same municipality 90
c) The same province 99

G) *Aparri*
1) Percentage of husbands and wives from:
a) The same barrio 81
b) The same municipality 83
c) The same province 87

H) *Bay*
1) Percentage of husbands and wives from:
a) The same barrio 74
b) The same municipality 83
c) The same province 89

I) *All surveys reported*
1) Percentage of husbands and wives from:
a) The same barrio 60
b) The same municipality 86
c) The same province 95

XIX. NUMBER AND AGE OF TENANTS CHILDREN

A) *Tigbauan*
1) Number of living children 153
a) Number dependent 152
i) Of 6 years of age or less 57
ii) Of 7-18 years of age 45
iii) Of 19 years of age or over 50
b) Number of self-supporting 1
iii) Of 19 years of age or over 1
2) Number of deceased children 101
3) All children 254

B) *San Miguel*
1) Number of living children 74
a) Number de pendent 42
i) Of 6 years of age or less 27
ii) Of 7-18 years of age 15
b) Number self-supporting 32
ii) Of 7-18 years of age 20
iii) Of 19 years of age or over 12
2) Number of deceased children 26
3) All children 100

C) *Santa Rosa*
1) Number of living children 283
a) Number dependent 203
i) Of 6 years of age or less 114
ii) Of 7-18 years of age 89
b) Number self-supporting 80
ii) Of 7-18 years of age 29
iii) Of 19 years of age or over 51
2) Number of deceased children 147
3) All children 430

D) *Hagonoy*
1) Number of living children 501
a) Number dependent 362
i) Of 6 years of age or less 149
ii) Of 7-18 years of age 156
iii) Of 19 years of age or over 57
b) Number self-supporting 139
iii) Of 19 years of age or over 139
2) Number of deceased children 251
3) All children 752

E) *Calasiao*
1) Number of living children 272
a) Number dependent 241
i) Of 6 years of age or less 115

ii) Of 7-18 years of age	97
iii) Of 19 years of age or over	29
b) Number self-supporting	31
iii) Of 19 years of age or over	31
2) Number of deceased children	181
3) All children	453
F) *Naic*	
1) Number of living children	343
a) Number dependent	276
i) Of 6 years of age or less	150
ii) Of 7-18 years of age	72
iii) Of 19 years of age or over	54
b) Number self-supporting	67
iii) Of 19 years of age or over	67
2) Number of deceased children	312
3) All children	655
G) *Aparri*	
1) Number of living children	259
a) Number dependent	174
i) Of 6 years of age or less	78
ii) Of 7-18 years of age	96
b) Number self-supporting	85
ii) Of 7-18 years of age	12
iii) Of 19 years of age or over	73
2) Number of deceased children	205
3) All children	464
H) *Bay*	
1) Number of living children	344
a) Number dependent	330
i) Of 6 years of age or less	137
ii) Of 7-18 years of age	135
iii) Of 19 years of age or over	58
b) Number self-supporting	14
iii) Of 19 years of age or over	14
2) Number of deceased children	304
3) All children	648
I) *All surveys*	
1) Number of living children	2,229
a) Number dependent	1,780
i) Of 6 years of age or less	827
ii) Of 7-18 years of age	705
iii) Of 19 years of age or over	248
b) Number self-supporting	449
ii) Of 7-18 years of age	61
iii) Of 19 years of age or over	388
c) Number of living children	
i) Of 6 years of age or less	827
ii) Of 7-18 years of age	766
iii) Of 19 years of age or over	636
2) Number of deceased children	1,527
3) All children	3,756
4) Percentage of children living	59
a) Percentage living and dependent	80
i) Of 6 years of age or less	47
ii) Of 7-18 years of age	39
iii) Of 19 years of age or over	14
b) Percentage living and self-supporting	20
ii) Of 7-18 years of age	14
iii) Of 19 years of age or over	86
c) Percentage of living children	
i) Of 6 years of age or less	37
ii) Of 7-18 years of age	34
iii) Of 19 years of age or over	29
5) Percentage of children deceased	41

XX. LITERACY OF TENANT FAMILIES

A) *Tigbauan*	
1) Number of tenants and wives in survey	97
a) Percentage literate	63

i) In vernacular only[14]	53
iii) In English[15]	10
b) Percentage illiterate	37
2) Number of living children in survey	152
a) Percentage literate	36
i) In vernacular only	27
iii) In English	9
b) Percentage Illiterate	64
3) Number of members of families in survey	250
a) Percentage literate	46
i) In vernacular only	37
iii) In English	9
b) Percentage illiterate	54
B) San Miguel	
1) Number of tenants and wives in survey	73
a) Percentage literate	62
i) In vernacular only	57
ii) In Spanish	1
iii) In English	4
b) Percentage illiterate	38
2) Number of living children in survey	74
a) Percentage literate	19
iii) In English	19
b) Percentage illiterate	81
3) Number of members of families in survey	147
a) Percentage literate	40
i) In vernacular only	28
ii) In Spanish	1
iii) In English	11
b) Percentage illiterate	60
C) Santa Rosa	
1) Number of tenants and wives in survey	155
a) Percentage literate	72
i) In vernacular only	68
iii) In English	4
b) Percentage illiterate	28
2) Number of living children in survey	283
a) Percentage literate	69
i) In vernacular only	44
iii) In English	25
b) Percentage illiterate	31
3) Number of members of families in survey	438
a) Percentage literate	70
i) In vernacular only	52
iii) In English	18
b) Percentage illiterate	30
D) Hagonoy	
1) Number of tenants and wives in survey	258
a) Percentage literate	45
i) In vernacular only	42
iii) In English	3
b) Percentage illiterate	55
2) Number of living children in survey	501
a) Percentage literate	54
iii) In English	54
b) Percentage illiterate	46
3) Number of members of families in survey	759
a) Percentage literate	51
i) In vernacular only	14
iii) In English	37
b) Percentage illiterate	49
E) Calasiao	
1) Number of tenants and wives in survey	191
a) Percentage literate	29
i) In vernacular only	23
iii) In English	6

14 Vernacular was taken to mean elementary ability to read and write any of the numerous Philippine languages.

15 Literacy in English normally carries with it literacy in the vernacular also.

b) Percentage illiterate	71
2) Number of living children in survey	272
a) Percentage literate	44
i) In vernacular only	18
ii) In Spanish	9
iii) In English	77
b) Percentage illiterate	56
3) Number of members of families in survey	463
a) Percentage literate	38
i) In vernacular only	20
ii) In Spanish	6
iii) In English	12
b) Percentage illiterate	62
F) Naic	
1) Number of tenants and wives in survey	298
a) Percentage literate	31
i) In vernacular only	22
ii) In Spanish	9
b) Percentage illiterate	69
2) Number of living children in survey	343
a) Percentage literate	65
i) In vernacular only	36
iii) In English	29
b) Percentage illiterate	35
3) Number of members of families in survey	641
a) Percentage literate	49
i) In vernacular only	28
ii) In Spanish	5
iii) In English	16
b) Percentage illiterate	51
G) Aparri	
1) Number of tenants and wives in survey	209
a) Percentage literate	38
i) In vernacular only	27
ii) In Spanish	4
iii) In English	7
b) Percentage illiterate	62
2) Number of living children in survey	259
a) Percentage literate	84
i) In vernacular only	24
ii) In Spanish	6
iii) In English	54
b) Percentage illiterate	16
3) Number of members of families in survey	468
a) Percentage literate	63
i) In vernacular only	25
ii) In Spanish	5
iii) In English	33
b) Percentage illiterate	37
H) Bay	
1) Number of tenants and wives in survey	315
a) Percentage literate	24
i) In vernacular only	21
iii) In English	3
b) Percentage illiterate	76
2) Number of living children in survey	344
a) Percentage literate	34
i) In vernacular only	1
ii) In Spanish	2
iii) In English	31
b) Percentage illiterate	66
3) Number of members of families in survey	659
a) Percentage literate	29
i) In vernacular only	10
ii) In Spanish	1
iii) In English	18
b) Percentage illiterate	71

I) All surveys	
1) Number of tenants and wives in the surveys	1596
a) Percentage literate	40
i) In vernacular only	34
ii) In Spanish	2
iii) In English	4
b) Percentage illiterate	60
2) Number of living children in the surveys	2229
a) Percentage literate	54
i) In vernacular only	18
ii) In Spanish	2
iii) In English	34
b) Percentage illiterate	46
3) Number of members of families in the surveys	3825
a) Percentage literate	48
i) In vernacular only	25
ii) In Spanish	2
iii) In English	21
b) Percentage illiterate	52

XXI. CLASS STABILITY

A) Tigbauan	
1) Number of tenants in survey	50
2) Number of adult relatives reported	384
a) Number who are tenants or married to tenants	209
i) Percentage	54.4
b) Number who are landowners	17
i) Percentage	4.4
B) San Miguel	
1) Number of tenants in survey	40
2) Number of adult relatives reported	199
a) Number who are tenants or married to tenants	103
i) Percentage	51.8
b) Number who are landowners	3
ii) Percentage	1.5
C) Santa Rosa	
1) Number of tenants in survey	81
2) Number of adult relatives reported	587
a) Number who are tenants or married to tenants	409
i) Percentage	70.0
b) Number who are landowners	34
ii) Percentage	5.8
D) Hagonoy	
1) Number of tenants in survey	138
2) Number of adult relatives reported	1,630
a) Number who are tenants or married to tenants	1,078
i) Percentage	66.1
b) Number who are landowners	0
E) Calasiao	
1) Number of tenants in survey	99
2) Number of adult relatives reported	991
a) Number who are tenants or married to tenants	862
i) Percentage	87.4
b) Number who are landowners	0
F) Naic	
1) Number of tenants in survey	151
2) Number of adult relatives reported	1,529
a) Number who are tenants or married to tenants	1,255
i) Percentage	82.1
b) Number who are landowners	0
G) Aparri	
1) Number of tenants in survey	111
2) Number of adult relatives reported	1,139
a) Number who are tenants or married to tenants	370
i) Percentage	32.5
b) Number who are landowners	48
i) Percentage	4.2

H)	*Bay*	
	1) Number of tenants in survey	160
	2) Number of adult relatives reported	1,019
	a) Number who are tenants or married to tenants	799
	i) Percentage	78.4
	b) Number who are landowners	14
	i) Percentage	.4
I)	*All surveys*	
	1) Number of tenants in the surveys	830
	2) Number of adult relatives reported	7,478
	a) Number who are tenants or married to tenants	5,085
	i) Percentage	68.0
	b) Number who are landowners	116
	i) Percentage	1.6

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HOG RAISING FOR BEGINNERS[1]

By B. M. GONZALEZ
Of the Department of Animal Husbandry

WITH ONE TEXT FIGURE

Pork is the staple meat food in the Philippines. While the use of chickens is more widespread, yet the consumption of pork in kilograms is vastly greater than that of poultry; and there is no meat that is more relished by the Christian Filipinos.

Interest in hog raising has increased steadily the past decade, and this has brought to the army of hog raisers a body of recruits who have had to learn their lessons by experience. We have been confronted from time to time with demands for information on the subject and it is in response to such requests that this article is written. Hog raising is not so easy an undertaking as is imagined by many who have never tried it. The writer does not presume nor will attempt to cover the whole subject in this necessarily brief article, but if he succeeds in giving some information on the subject that will be of value to the beginner and will stimulate him to think about and to study and appreciate the problems that will confront him, he will have attained his purpose.

So many young people, and older ones too, desire to raise live stock to "get rich quick." Such persons will likely be disappointed if that is all their equipment for their undertaking. Animal industries concerned with the actual production of live stock have never paid big dividends until time has passed and hard work has been put in them. Men with the idea of quick returns will do better in the utilization end of the live stock industry, that is, animal trading and slaughtering, than in production.

The production of live stock is a steady enterprise and requires patient work to make it a success. It is a business for the home lover who is content with an independent and moderate living and is willing to work hard for it. It is not a business for the capitalist. There are so many little pitfalls connected with the industry that it takes the personal attention of the owner, himself, to see them.

HOW TO BEGIN

The beginner would do well to start hog raising on a small scale, rather as a side line to his usual occupation, and as he learns the details of the business he can determine to what extent it is profitable for him to expand. Three hectares of land and ten sows is as large a beginning as one new in the business should

[1] Experiment Station contribution No. 224; Circular No. 1.

attempt. He can start on much less than this, but there might not be enough in it to keep his attention.

The beginning hog raiser should plan his grounds in such a way that they may be divided into lots about equal in size. This division is to enable him to rotate pastures; also to plant a crop of corn once in a while and utilize the fertility accumulated in the land through the manure of the hogs, and to bury by plowing a great multitude of parasites which pollute the ground after animals have been kept on it for some time.

He should establish a central hog house easily accessible from all the lots. The central hog house is most useful during farrowing time. In it may be kept hogs about to farrow so that those needing attention may be close by, and the little pigs will be under favorable conditions for proper development. Each compartment in the hog house should be about 2½ x 2½ meters and there should be allowed an average of one compartment for every two sows kept in the herd. The size of the house will, of course, depend on how many sows one desires to keep. The floor of the house should be of concrete that it may be dry, sanitary, and easy to clean. The sides may be made of bamboo or lumber. The roof may be of nipa or tile. Lumber siding on a concrete foundation will last longer than bamboo and will prove more economical in the end. The roof should be set low enough to afford protection from driving rains so the sides need not be higher than is necessary to keep the hogs in the compartments.

It is possible to keep hogs in the Philippines without any provision for housing. The weather is mild throughout the year and the pigs can be left in the open where there are trees here and there to protect them from the heat of the midday sun. The house, while not indispensable, is very convenient, however, as it furnishes a central place for the different events and operations in connection with the running of the plant, as in farrowing, castrating, catching for the market, isolation of sick pigs, breeding, mixing feeds, feeding, etc. Without a central house the yard or grounds, where feeding is done, is likely to be muddy and very insanitary as well as inconvenient for work.

When the hogs are pastured in the fields, they should be given shade. If there are large trees no further provision is necessary. If there are none, a framework covered with palm leaves gives sufficient protection from the heat of the sun.

SELECTION OF STOCK

It is best to look around in the neighborhood for a prolific mother and contract for as many of her female pigs as are desired before they are weaned. If the selection is delayed, it is more than likely that the pigs will be sold for *lechon* (roast suckling pig) as there are few of the poorer families that can afford to bring up to maturity a large litter of pigs. Also it is cheaper for the beginner to buy the pigs while very young, and this is a good age of stock for him to learn his first practical lessons in pig raising. The pigs selected should be from a mother of fair size and with ten to twelve pigs to the litter. A sow with less than eight pigs cannot be considered as prolific. The advantage in having prolific sows is that one does not need to keep so many to produce the pigs needed. For example, if one intends to feed to maturity fifty pigs, he will need to keep ten sows if the average number in a litter is only five, but if they bear ten pigs at a time, then he needs to keep only five sows. He will therefore save a large amount of

money as he will be feeding only five sows instead of ten to produce the same number of pigs. The boar should be a pure breed, a Berkshire for example. The progeny of such a boar out of native sows are called *grades*. They are generally better looking than pure native pigs, grow faster, fatten quicker, and are much tamer. Also grade pigs are not very susceptible to disease.

IMPORTED BREEDS

Several imported improved breeds have been brought into the Islands from time to time, such as the Berkshire, the Duroc Jersey, the Poland China, the Tamworth, and the Yorkshire. None of these breeds has been found to be fully adapted to Philippine conditions, that is, climate, feeds and the native method of hog raising. As they have a tendency to grow fast, they require more feed at each meal to keep them in good condition, much more than is generally given the native pig, and better balanced as to its nutrients. In return for this extra feed they produce pork correspondingly faster. However, there are many disadvantages with these improved breeds: (a) They are not so prolific as native hogs, often averaging no higher than five pigs to each litter and frequently even fewer; (b) They are susceptible to a number of diseases which have apparently little effect on native pigs, as kidney worms and round worms; (c) Even those that are able to endure these diseases longer do not usually live beyond two years and a half. It is rare to find pure bred pigs in the Philippines older than three years. (1)

For the present, then, it is not recommendable to raise pigs higher than 50 per cent of some pure breed. As stated above, such grades have been found by experience to be almost as easy keepers as the native pigs and return better profits. They are good market pigs.

As to which of the pure breeds enumerated above is the best to get a boar from, there is little difference. All in all, the Berkshire and the Duroc Jersey are the most recommendable for the Philippines at present. A brief statement of the characteristics of these breeds follows.

The Berkshire.—This is one of the oldest breeds of hogs and is very popular in the Philippines, especially the individuals with short up-turned snouts. The Berkshire is black with six white points at the face, at the four feet, and at the switch of the tail. With pure black native pigs the grades, or *mestizos* are colored much like the father. With black and white spotted pigs some of the young are almost pure black while others are spotted much like the mother. While not very well suited to the Philippines, the Berkshire among improved pigs is probably the best adapted to our conditions.

The Duroc-Jersey.—This is an American breed that is of comparatively recent origin. Its color is solid red, varying in shade from light to dark. It has a longer and more pointed snout than the Berkshire. It has proven about equal to the Berkshire in its adaptability to local conditions.

The Poland China.—This breed is also American derived in part from the Berkshire. It has more quality and fattens easier than the Berkshire, but is not so hardy. Its color is the same as the Berkshire. Its face is straight, rather than dished like the latter. It has not proven very hardy in the Philippines.

The Tamworth.—This is an English breed of red pigs colored somewhat like the Duroc-Jersey. It is a bacon breed and the form of its body is long, tall and thin, not like that of the other breeds mentioned, which is short, broad, and com-

pact. It has a long snout and stands on long legs. Due to these characteristics and the form of its body, it is not popular in the Philippines, as the people see a great similarity between it and the wild hogs.

The Yorkshire.—This is an English breed of white hogs. They have been imported into the Islands rather recently and have therefore no reputation established, either good or bad. They seem to be doing well, so far. Their color is a great drawback to them in this climate. White skin blisters easily under the heat of the sun. They are also difficult to keep clean. Its grades with native pigs are white, but as most native pigs are black, the offspring with this breed after the first generation are bound to lack uniformity in color.

Boars of the breeds named above may be purchased from the Bureau of Agriculture for about ₱30 at about weaning age; if older, the price is more.

MANAGEMENT

WHEN TO BREED

Native pigs that have been fed properly will generally take the boar when about 10 months old. It is a good plan to breed the sows at this time. Age is only an approximate guide, however, as more depends on the development of the animal. Well grown animals may be bred earlier, while slow maturing and inadequately fed animals may not be ready to breed until much later.

THE SOW

If a sow farrows not more than six pigs and proves to be a poor mother, she should be fattened after weaning her pigs and sold or butchered. If she farrows about eight or more and raises them well, then she may be kept longer. The second litter is likely to be larger than the first. Sows that have proven to be good mothers should be kept as long as possible, as they are better capital than unknown young sows.

If the sow and her brood are fed and cared for properly, the sow may be bred soon after weaning her litter and thus produce two litters in one year. In practice, however, three litters in two years is about all that may be expected.

The pregnant sow may be allowed to run with the rest of the herd. She should have sufficient feed, however, to properly develop her young pigs as well as store some fat which will serve later as reserve in nursing the growing pigs when born. At this time she can have rice bran, or *tiqui-tiqui*, and some corn. She should be allowed to graze and in case she cannot be conveniently turned to a grassy lot she should be given green forage. Stalks of peanuts will be very valuable for this purpose. Any other legume that the animal will relish will be equally as satisfactory.

Knowing when the sow was bred, count 112 days ahead, and it will not be many days away from that when the sow will be ready to farrow. Native sows will generally steal away at that time and make their nest in some secluded place where they will not be molested. If one has a hog house, after cleaning it thoroughly the sow should be confined in it before farrowing. She may be given rice straw or clean dry banana leaves for nesting material. The sow is likely to miss one or two meals at this time which should cause no alarm. She should be given plenty of water.

THE PIGS

When about four weeks old, the little pigs will begin to taste the feed of the mother and will gradually eat more and more every day. They should be encouraged to do this, as they will grow faster; the feed should be increased accordingly. The pigs may be weaned when 10 to 12 weeks old.

NUMBERING

To identify the pigs, and to keep a proper record of their ancestry and their age, a system should be followed. The one shown in the illustration is widely used by hog men and is very satisfactory. Notches are cut on the pig's ears with a sharp knife as follows:

1 = notch on lower edge of right ear
10 = notch on lower edge of left ear
3 = notch on upper edge of right ear
30 = notch on upper edge of left ear

If one desires any number, all he will have to do is to combine any two or more numbers. For example: 2 will be indicated by making two punches on the lower edge of right ear; 16, by notching the lower edge of the left ear once and the upper edge of the right ear twice, and so on. In case he has exhausted the numbers, then he may start from number 1 again. By that time the earlier numbered pigs will have been mostly disposed of, and the few that remain may be easily distinguished from the younger ones of the same number.

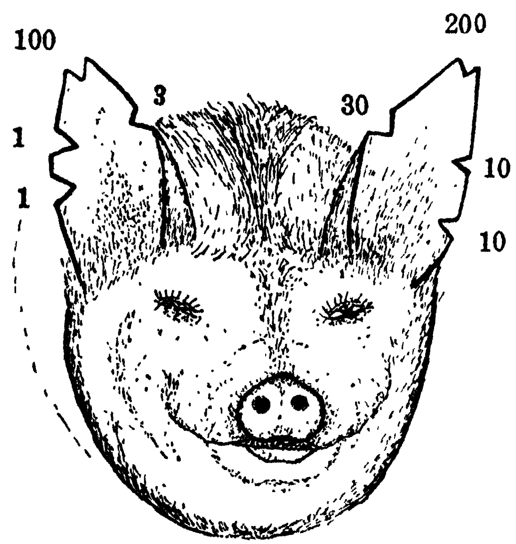

Fig. 1.—Diagram showing a system of numbering pigs by means of notches on the ears

CASTRATION

Young males not desired for breeding should be castrated as early as possible. The older the animal the more he resents the operation. Vigorous pigs may be castrated when about six weeks old. At this time they scarcely notice the operation. When delayed until after weaning they generally suffer more from it as weaning itself causes them considerable disturbance. The operation is very

simple and may be performed with any size of pigs. The danger increases, however, as the size of the pig increases. An attendant catches the pig and holds him on his back on a box or bench and exposes the scrotum. It is then washed thoroughly with a piece of cotton or clean rag dipped in some antiseptic solution, as 3 per cent creolin or carbolic acid. The attendant disinfects his hands, and with a sharp knife cuts a longitudinal incision and exposes one testicle. The testicle should be freed of the membranes and these be allowed to retract. The cord is then pulled steadily but not too strongly. Then with a dull, and preferably nicked but clean knife, the cord is cut. If only a sharp knife is available, the cord should be scraped with it instead of cut, as cutting will cause profuse bleeding. The operation is repeated on the other testicle. The incision should be long enough to insure good drainage. It need not be sewed up after the operation as it heals better without. After the operation, rub a mixture of vaseline and tar on the wound to keep away the flies. The newly castrated pigs should be turned on a clean cement floor or on a dry clean grass lot until their wounds are fairly well healed.

Ruptured pigs, that is, pigs in which the intestines are able to pass into the scrotum, are more difficult to handle. Their castration should be left to a trained operator. It is preferable that these be sold when young for *lechon* rather than to run the risk of losing them in castration.

WEANING

When about ten weeks old the pigs may be weaned; if they are not very vigorous, weaning may be delayed two or three weeks longer. Weaning should not be done suddenly, as the sow is likely to have udder trouble if her pigs are removed all at once. The pigs may be separated and returned to the mother about two or three times a day for short intervals at first in order to empty her udders. These intervals should be decreased gradually until complete weaning is accomplished. At the same time, the feed of the mother should be decreased considerably. She should be watched closely, as she is likely to come in heat at about the third day after weaning her pigs. If bred then, conception is likely to follow and another litter of pigs may be expected after about 112 days.

FEEDING THE YOUNG PIGS

The weaned pigs may be given the same ration their mother was getting. If the pigs are on a lot where there is abundant forage a ration consisting of one part corn, one part copra meal, and two parts rice bran, or *darac* will be found satisfactory. If pigs cannot get green feed, the gains will be much slower. At such times the addition of some feed rich in animal protein is desirable. In many places in the Philippines small shrimps, or *hipon* are plentiful. These may be given in the proportion of 10 per cent of the total feed if fresh, or 5 per cent if dried. When the pigs reach six months of age they will need the animal protein feed less. The pigs then may be fed more corn in proportion.

COMMON PHILIPPINE FEEDS

CORN

Corn is a fattening feed, and should not be given in a higher proportion than one third of the total feed for brood sows, boars, and young pigs. For fattening pigs as much as two thirds of the ration may be corn. When pork retails

at ₱1.00 a kilogram, corn cannot be fed profitably if it costs more than ₱6.00 a cavan (58.5 kg. shelled), or ₱1.20 for 100 medium ears, or 10 centavos a kilogram, shelled.

RICE BRAN, (DARAC, OR TIQUI-TIQUI)

Rice bran is a fattening feed, also, but has laxative effects. For growing pigs, brood sows, and boars, as much as two thirds of the grain ration may be rice bran. For fattening pigs more than one third of the ration should be *darac.* There are two kinds of *darac,* or *tiqui-tiqui* in the Philippine market. One comes from small combination mills which hull and polish the rice all in one process so that the by-product is a mixture of hulls, bran, and broken grains, or *binlid.* The other comes from larger mills. In these, the hull is kept separate and there is less broken grain mixed with the bran. The first kind has very poor feeding value and is worth only about one half of the bran from the larger mills yet its price is often two thirds as much. The bran from the large mills is the kind to be purchased. It has a feeding value that may be placed conservatively at from 10 to 25 per cent more than the same weight of corn. (2) When pork sells at ₱1.00 a kilogram one cannot afford to feed rice bran higher than ₱2.85 a cavan of about 26 kilograms, or 11 centavos a kilogram.

COPRA MEAL

This is a comparatively abundant as well as cheap feed in the Philippines. Not more than one third of the ration should be of this feed, and preferably less, if other feeds are available and as cheap. When pork retails at ₱1.00 a kilogram one should not pay more than ₱84 a ton for copra meal or 8 centavos a kilogram.

SWEET POTATOES

A field of sweet potatoes on which growing pigs can be turned to forage is one of the easiest ways of giving them the green feed they need. Sweet potatoes grow well all over the Islands and during the whole year. The leaves, as well as the roots, are relished by pigs (3). If not pastured too closely the tubers will grow continuously for a long time, thus reducing the cost of replanting. Sweet potato tubers can be substituted for corn in the proportion of 3½ kilograms sweet potatoes to 1 of corn. If the price warrants it sweet potatoes may be substituted for as much as one half of the total grain ration.

COWPEAS

This crop grows well in the Philippines, and when pigs are turned to it at the time the pods are beginning to ripen, or about two months after planting, it furnishes a rich nitrogenous supplement to the feed in addition to its forage value. While the plants keep on growing even after the pigs are turned on the pasture, they are killed after a while and replanting is necessary (2).

CORN FORAGE

Standing corn makes a good feed if pigs are turned in at about the time the grains are beginning to turn hard, or shortly after the roasting stage. The pigs will save labor by doing the harvesting themselves, and will make comparatively large gains. They will consume the corn in this way, however, much faster than if the corn was given to them in the feed lot, and the gains are comparatively more expensive.

Approximate maximum price that should be paid for feeds when pork sells at ₱........... per kilogram.

Price of pork.	₱0 50	₱0.60	₱0.70	₱0.80	₱0.90	₱1.00	₱1.10	₱1.20
Feeds								
Corn:								
Shelled, per kg.	.05	.06	.07	.08	.09	.10	.11	.12
Shelled, per cavan.......	2.90	3.50	4.10	4.70	5.25	5.85	6.45	7.00
Ears, medium per 100....	.60	.72	.84	.96	1.08	1.20	1.32	1.44
Rice bran:								
(Good grade) per kg.	.05	.07	.08	.09	.10	.11	.12	.13
Per cavan of 26 kg. . .	1.43	1 72	2 00	2.30	2.58	2.87	3.14	3.44
Copra meal:								
Per kg.	04	05	.06	07	.07	.08	.09	.10
Per ton	41 50	50 00	58 50	66 50	75.00	84.00	92 00	100.00

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LEAF BLIGHT OF CORN[1]

By Severo Marquez

Leaf blight is one of the most common diseases of corn (*Zea mays* L.) in the Philippine Islands. Field plants of all varieties always show the symptoms of the disease. Introduced varieties are usually severely attacked. The Filipino farmers do not consider the disease to be harmful so give it no particular attention.

THE DISEASE

GEOGRAPHICAL DISTRIBUTION

According to Butler (1) leaf blight of corn is the most common disease in many parts of India and the only disease that has been observed every year to a greater or less extent at Pusa. It was first described in Italy in 1876, and has since been reported in the United States, South Africa, Japan, and the Philippines. Robinson (2), reported that in some parts of the United States the leaf blight fungus was found severe and destructive as far back as 1889.

According to Hunt (3), a leaf blight of corn produced by *Helminthosporium gramineum* (Rab.) Erik. was found in America in 1907 causing extended, brown, and elliptical dead areas on the leaves. Stevens and Hall (4) also in America, reported in the year 1910, that leaf blight of corn gives a somewhat frost-bitten appearance to the leaves, with a thin green-olive mold on the lower sides. Reinking (5) first found the disease in the College of Agriculture at Los Baños, Philippine Islands. In the year 1918, Reinking (6) also found the same fungus on corn plants in China.

ECONOMIC IMPORTANCE

In north-eastern United States *Helminthosporium* causes much loss (2). Serious damage has also been recorded from the fungus in Italy.

Reinking (5), found that entire plots of sweet corn were destroyed by leaf blight. In order to determine the severity of the disease, twenty different varieties of corn planted in the College of Agriculture were observed and the degree of infection noted. It was found that Montellano's Corn, Yellow Flint, Chinese Waxy Endospern, Fenchy Salvador, Laguna Mexican, Mismis, and the Los Baños White were slightly attacked. Mexican June Corn, Moro Corn, Early Flint Sweet Corn, Señora, *Zea mays indentata*, *Zea mays everta*, Argentina Pop Corn, Yellow Flint, Cebu White Flint, Guam Corn Flint, and Bolero F had medium infection. White Pearl, Guam White Dent, Forlorn, and the Country Gentleman Sweet Corn were severely infected. In general the native varieties were slightly infected by the fungus.

SYMPTOMS OF THE DISEASE

EARLY STAGE OF INFECTION

The early stage of the disease on the field corn plants is characterized at first by minute yellow roundish spots on the leaves, which gradually increase in size,

[1] Thesis presented for graduation from the College of Agriculture, No. 174. Experiment Station contribution No. 225. Prepared in the Department of Plant Pathology under the direction of Professor Otto A. Reinking.

generally becoming somewhat oval in shape. As the spots become older, their long axes run parallel to the veins of the leaves. They elongate into stripes. The spots may run together forming a large spot and may cover the entire leaf surface. In the inoculated plants the first symptoms of the disease are spots on the leaves with water-soaked borders. They increase in size, become yellowish in color, and finally turn brown.

ADVANCED STAGE OF INFECTION

When the spots are old, they have light yellowish to gray centers around which is a brownish colored tissue. A black mold composed of conidiophores and conidia is produced in the center of the old spots. This is visible to the naked eye.

CAUSAL ORGANISM

METHOD OF ISOLATION

A young diseased portion from the leaf of corn was cut off with a pair of scissors and disinfected with a 1 to 1000 mercuric chloride solution for thirty seconds. Then it was washed three times with sterile water in test tubes to remove the disinfectant. Finally, it was transferred to the potato agar in sterilized petri dishes by means of a sterilized platinum needle. After one day a white growth of mycelium was noted around the leaf section of the agar in the petri dishes. A portion of the mycelium was transferred to a test tube with potato agar. The cultures were transferred twice a month to other test tubes.

MORPHOLOGY

Mycelium.—The mycelium grows very abundantly in masses. It is septate, slightly constricted at the septa, branched and somewhat granular. It is hyaline when young and light brown when old. Twenty cells of the mycelium were measured and they were found to be 18-40 microns x 4-6 microns.

Conidiophores.—The conidiophores arise in clusters. They are pale in color in the earlier stage of development and yellowish brown when old. They can be easily distinguished from the mycelium. They are septate, and somewhat granular. Twenty conidiophores were measured and these were found to be 96-148 microns x 8-10 microns. Each conidiophore varies from 4 to 8 cells depending upon the age.

Conidia.—The conidia are borne at the tips of the conidiophores. The conidia are wider at the middle and gradually taper toward the two ends. They are septate, and are crescent-shaped. Two hundred spores were measured and these were 36-112 microns x 10-18 microns.

The results of the measurements of conidia made by the writer are very similar to the result obtained by Stevens (7). The writer found that the conidia are 36-112 microns x 10-18 microns. Stevens (7) found that the conidia were 80-120 microns x 20-24 microns. The writer is therefore of the opinion that the species causing leaf blight of corn in the Philippines is *H. inconspicuum* Cke. and Ell.

PHYSIOLOGY

On September 1, 1920, four different kinds of culture media were prepared in the laboratory. On September 2, 1920, these media were inoculated with the conidia of the fungus taken from the pure culture previously prepared. Daily observations for fifteen days were made after the transfer of the fungus to the media.

Growth on potato agar.—The growth of the fungus on this medium was faster than on any of the other three media used.

Growth on sterilized potato cylinders.—At the end of fifteen days the fungus was as black as the culture on potato agar; it ranked second with respect to growth.

Growth on sterilized corn stalk.—The growth on the corn stalk was less pronounced than the growth on potato agar and sterilized potato cylinders. After fifteen days it was as black as the growth on potato agar and potato cylinders.

Growth on sterilized bean pods.—The growth of the fungus on the bean pod was the slowest. The whole pod was thinly covered by the fungus. The fungus did not turn as black as the growth on the potato agar, potato cylinders, or corn stalk.

RELATION OF SPORE PRODUCTION TO MEDIA

On the tenth day after the transfer of the pure culture of the fungus to potato agar, potato cylinders, sterilized corn stalk, and sterilized bean pods a microscopic examination of the fungus taken from each culture medium was made. Spores were found in the cultures grown on the four media used. It was found that spores were formed after seven days on potato agar in the previous cultures.

GERMINATION OF SPORES

Three trials were made in germinating the spores or conidia of the fungus. The first trial was made July 20, 1920. A small mass of conidiophores and conidia taken from the pure culture was mounted on a glass slide and put under the microscope. In the first trial it took 15 hours for the conidia to germinate. The second trial was made on July 22, 1920. In the second trial it took three hours for the spores to germinate. The third trial was made on the same day as the second. Conidia were found germinating after two hours.

LONGEVITY OF THE SPORES

Twenty-four leaves of corn severely infected with *Helminthosporium inconspicuum* were gathered in the field. Twelve of these leaves were kept outside of the laboratory, exposed to rain and sun, and the other twelve were kept in the laboratory. The experiment was started on October 19, 1920, and closed on January 25, 1921. A few spores were taken from the two specimens at three-day intervals until the spores were found not viable.

The writer found that the spores taken from the specimens kept outside contained more viable spores over a longer period than those kept inside. Of the 34 trials made, the last four for the specimens kept inside, and the last two for the specimens kept outside, gave no germination. The specimens that were kept outside remained viable for a longer time than those kept inside. In both cases, the spores were found still viable three months after the specimens had been gathered in the field. The specimens which were kept in the laboratory, not being exposed to moisture, did not live as long as those kept outside. From this, the writer concludes that moisture favors the germinating power and longevity of the conidia. The specimen which was kept in the laboratory was still in a good condition when the experiment was closed, but the conidia were not viable. The specimens kept inside showed no germination nine days before the outside specimen ceased to germinate.

PATHOGENICITY

To test whether the isolated fungus from the leaf spots of corn would cause trouble similar to the spot in the field inoculation, experiments were made. Plants grown in the laboratory and in the field were inoculated.

Conidia from a pure culture of the fungus was transferred from a test tube of potato agar to the atomizer with sterilized water by means of a platinum needle. The plants were sprayed with the conidial suspension in a very fine mist. They were then covered with bell jars on the table in the laboratory. Daily observations were made both on the inoculated plants and on the control.

According to the observations made, the spots were formed on the leaves of the plants in the laboratory on September 16, 1919, one day after the inoculation of the potted plants. On September 18, 1919, three days after the inoculation of the plants in the field, a few minute yellow specks were observed on the plants. Spots with water-soaked borders were first observed on the potted plants, while a slight yellowing in the form of spots was found or the corn plants inoculated in the field. The plants grown in the field showed signs of the disease two days later than those which were grown in the pots. This was probably because the plants in the laboratory were more tender than those grown in the field. The control was not infected. In order to be sure that the fungus was the real cause of the disease, re-isolation was made from both the inoculated plants in the laboratory and in the field. In both cases a fungus similar to the original one was obtained. The method employed in the re-isolation experiment was the same as that employed in the isolation experiment.

On August 18, 1920, twelve small pots with soil were sterilized in the autoclave, and five seeds of corn were planted in each pot after the pots had been sterilized and cooled. The seeds were disinfected with a 1 to 1000 mercuric chloride solution for thirty seconds before they were planted. The pots were divided into three lots, each lot having four pots. The soil in the first four pots was inoculated with the pure culture of the fungus before the seeds were planted. The plants in the second four pots were inoculated after the seeds had germinated. The last four pots were used as the control. All the pots were covered with bell jars on a table in the laboratory. Daily observations were made on the three lots till the end of the experiment.

It was found that the plants from the inoculated soil were infected two days after the seeds germinated. The plants whose leaves were sprayed with conidial suspension were infected a day after they had been inoculated. The control plants remained healthy. The results show that the fungus in the soil can infect the plants after they have germinated. The spots in both lots turned yellow in color. Some of the infected leaves in each lot were cut and decolorized in a solution of acetic acid and alcohol. The decolorized leaves were mounted in glycerine on glass slides and the conidiophores and conidia were observed in the corn leaf tissue.

METHOD OF INVASION

It was found that the fungus entered through the stomata, and directly through the leaf tissues.

DISCUSSION OF RESULTS

It was found from observations made on the twenty varieties of corn used that six varieties were slightly infected by the fungus, ten varieties showed me-

dium infection, and four were severely infected. The native and acclimatized varieties were slightly infected while the imported new varieties were severely attacked.

It was found that the early symptoms of the disease were the presence of watery spots on the leaves in case of the plants grown in the laboratory, and yellow spots in the case of the field plants. In both cases the spots increased in size, turned yellow and then brownish. The old stage of the spots was covered with black mold which was composed of conidiophores and conidia.

In the study of the causal organism, it was found that the fungus grew very well on potato agar. Through the isolation experiment it was noted that the growth of mycelium on potato agar one day after the transfer of the diseased part was very evident. The infection experiments showed that the fungus grown in pure culture readily infects the corn plants. The plants grown in the laboratory were more susceptible to the fungus than those grown in the field. As shown by the decolorized leaves taken from the inoculated plants, the fungus enters through the stomata and through the leaf tissue by directly penetrating through it. It was also observed that the corn seeds disinfected with 1 to 1000 mercuric chloride solution, and planted in sterilized soil were free from the fungus provided that they were kept in a controlled condition. Soil inoculation also showed that the spores in the soil may infect the young plants.

Morphological studies showed that the organism had one type of spores which vary in dimensions and in number of septa.

Butler (5), Stevens (6), and the writer obtained different measurements of the spores of the organisms which they studied. The writer's result, however, was more nearly like that obtained by Stevens, so that the organism is to be referred to *Helminthosporium inconspicuum*.

The organism grew best on potato agar Bean pod was a poor substratum for this fungus, because its growth on this medium was very slow. When mounted in water the conidia germinated within two hours at 31°C, producing one or two germ tubes, one at each end. The spores were found still viable three months after the specimens had been gathered from the field and kept in the laboratory, and it is very probable that they may remain viable even for a longer time. The diseased parts do not decay when they are kept from moisture and they la t longer than those exposed to moisture, but in case of the viability of spores it is better for the spores to be exposed to weather conditions. Spore-catching experiments showed that the spores are probably blown by the wind. Further work however needs to be done on this phase of the problem.

SUMMARY OF CONCLUSIONS

(1) Leaf spots caused by *Helminthosporium inconspicuum* were found on all varieties of corn planted in the College of Agriculture.

(2) Imported varieties are more susceptible to the fungus than the native and foreign but acclimatized varieties.

(3) Spores and conidiophores are formed on the older spots.

(4) Plants grown in the laboratory are more readily infected by the fungus than plants grown in the field.

(5) The fungus enters through the stomata of the leaves, and by direct penetration through the leaf tissues.

(6) *Helminthosporium inconspicuum* produces one type of spores which vary in size and number of septa.

(7) It was found that the older leaves of the plants grown in the field were severely infected.

(8) Conidia and conidiophores germinate by means of germ tubes, the conidia producing one or two germ tubes, one at each end of the conidium.

(9) The spores may germinate within two hours in a drop of water at 31°C. room temperature.

(10) The conidia remained viable as long as three months when kept in the laboratory, and as long as seven months from the time the plants were infected to the time that the conidia lost their viability.

(11) The spores in the soil may infect young corn plants.

(12) The wind is probably a means by which the spores are carried from one corn plant to another.

(13) White Pearl, Guam White Dent, Forlorn, and Country Gentleman sweet corn were the varieties severely infected by the fungus in the College of Agriculture.

RECOMMENDATIONS

The recommendations herein formulated are based on observations and from the results of the experiments.

(1) It is recommended to practice crop rotation, because the spores in the soil may infect the corn plants when planted in a field where corn has just been harvested.

(2) If possible, plant only resistant varieties of corn. Native and acclimatized foreign varieties are to be preferred.

(3) Imported varieties should be planted in isolated fields.

(4) Manure or compost made from leaves on diseased fields should not be used as fertilizers for corn.

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STUDIES ON PHILIPPINE POULTRY FEEDS I: AVAILABILITY AND PALATABILITY [1]

By NICASIO A. TUASON and F. M. FRONDA

Perhaps, of all the factors that control production, feeding is by far the most important, as about sixty per cent of the cost of production is traceable to feeds. In the art and science of poultry feeding, there are many factors that should be considered, but ranking in their order of importance, the availability and palatability of the feeds head the list.

So far no studies have been made along these lines in the Philippines, although of the many obstacles that tend to discourage poultry raisers in the Archipelago, the lack of information on the proper methods of feeding is the greatest. In the United States a number of palatability tests have been conducted in several places, but as the feeds used in these studies are not the same as are used in the Philippines, the results obtained cannot be applied to our conditions.

The purpose of the studies reported in this paper was to find out the feeds, with regard to palatability and availability, best suited to our native poultry. The relative consumption of a certain feed as compared with others available to the fowls at the same time is the criterion used for palatability in this study. These studies were made from August 4, 1922, to December 29, 1922, covering a period of sixteen weeks.

AVAILABILITY

With regard to availability and price of feeds that may be used for feeding poultry in the Philippines, no experiments need be conducted. The annual statistical reports published by the Bureau of Agriculture are sufficient to show whether or not certain grain feeds can be had and fed profitably in certain localities. Usually, however, the only feeds that can be fed profitably in this country are the ones produced by the poultryman himself. A list of possible feeds that may be used for this purpose is given in Table I. This table is derived mostly from Appendix Tables I, II, and III in Henry and Morrison's *Feeds and Feeding*. The digestible coefficients for ruminants with fiber excluded were used, inasmuch as poultry cannot digest fiber. As far as such factors are available, the digestible coefficients for poultry were used. These factors were available only in the cases of cracked corn, corn meal, and potato.

[1] Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Science in Agriculture, No. 175. Experiment Station contribution No 225. Prepared in Department of Animal Husbandry under the direction of Doctor F. M. Fronda. With later notes and data added by F. M. Fronda.

TABLE I.—*Showing the average analysis and digestible nutrients in 100 kilograms of feeds that may be available for poultry.a*

Feeding stuff.	Total ash.	Total crude fiber.	Digestible nutrients.		
			Crude protein.	N-Free extract.	Fat.
Corn, cracked	1.5	1.5	8.9	63.2	4.3
Corn meal	1.3	2.3	7.0	64.1	3.4
Corn bran	2.4	9.8	5.8	49.9	4.6
Rice, rough	4.9	9.3	4.7	61.4	1.7
Rice polish	4.8	1.9	8.0	56.7	7.5
Rice shorts (*binlid*)	2.2	0.8	9.2	71.7	2.0a
Rice bran	13.2	13.6	6.9	34.1	6.3c
Rice meal	9.1	9.3	7.3	44 8	10.6
Sorghum	1.9	2.0	7.5	59.5	2.6
Copra meal	7.3	15.7	15.8	36.6	5.8c
Cowpea	3.4	4.1	19.4	51.9	1.1
Soy bean	5.3	4 3	30.7	19.3	14.4
Soy bean, fat extracted	5.4	5.3	38.1	28.7	5.0
Mungo	3.0	4.4	20.4	56.6	0.9b
Sunflower seed	3.1	27.9	13.5	15.1	20.3
Peanut without hull	2.2	2.6	24.1	14.7	40.4
Peanut, waste	5.4	6.2	22.0	13.0	30.1
Cow's milk	0.7	——	3.3	4.9	4.3
Whey	0.7	——	0.8	4.7	0.3
Fish meal	32.0	——	40.9	——	2.2
Dried shrimps	19.7	4.2	55.6	3.3	2 6a
Snails, fresh	6.1	——	7.6	7.3	0.8a
Fresh bone, ground	21.1	——	18.3	——	24.5
Bread	1.5	0.7	5.8	51.5	0.5
Bakery refuse	5.2	0.5	8.3	60.5	7.0
Cabbage, outer leaves	3.1	2 8	1.7	4.3	——
Mixed grasses	1.8	10.6	1.7	8.6	0.6
Potato	1.1	0 4	1 1	15.7	——

a Derived mostly from Appendix Tables I, II and III in Henry and Morrison's *Feeds and Feeding*, 1917, and from various other sources.

a Actual analysis reported by the Department of Chemistry, College of Agriculture, University of the Philippines.

b Actual analysis reported by the Bureau of Science, Manila.

c Computed from actual analysis reported by the Department of Chemistry, College of Agriculture, University of the Philippines.

Of the grains, rice and corn seem to be the most popular, as these are raised in all the provinces in the Philippines. Filipinos seem to be awakening to the possibilities of raising and using sorghum as a poultry feed. Of the ground feeds, rice bran, *binlid* (rice shorts), and copra meal, being by-products, are cheap feeds and are therefore very popular. Rice bran and *binlid* are by-products of rice, the staple food of the Filipinos, and copra meal is a by-product obtained in the extraction of coconut oil from copra, one of the principal products of the Philippines. Snails, shrimps, either dried or fresh, and refuse fish may be the principal sources of animal proteins. The use of any of these feeds, however, depends upon conditions in different localities. Cowpeas, soy beans, mungo, and peanuts can be used as poultry feeds if these can be produced cheaply. A very careful selection and combination of these feeds will aid considerably in reducing the cost of poultry feeding, which would mean greater gains for the poultryman.

PALATABILITY

Ten hens, six capons, and two roosters, making a total of eighteen fowls were used in this study. This choice of birds was used instead of any single type of poultry, so the group would be representative, hence, the results would be more conclusive. The fowls were all healthy and vigorous, and varied in age from

four months to over a year. Before starting the experiment, they were fed a ration of one part by weight each of corn and palay every morning and afternoon so as to get them acquainted with the caretaker.

In the experiment both carbonaceous and protein feeds were used in the first part, and in the second part mash mixtures supplemented with grain. The carbonaceous feeds used were corn, rice, rice bran, and sorghum, and the protein feeds were copra meal, soy beans, cowpeas, mungo, dried shrimps, dried fish, *calamismis* meal[2] and blood meal.

In the second part of the experiment, the following mash mixtures were used:

No. 1. Rice bran and copra meal.
No. 2. Rice bran and blood meal.
No. 3. Rice bran and *calamismis* meal.
No. 4. Rice bran and mungo meal.
No. 5. Corn meal and copra meal.
No. 6. Corn meal and blood meal.
No. 7. Corn meal and *calamismis* meal.
No. 8. Corn meal and mungo meal.

In the first four combinations, rice bran was the basic part, two-thirds by weight being supplied, the other constituent forming one-third. In the last four mixtures, corn meal was the basic part, two-thirds by weight, the other constituent being one-third.

The birds were housed in one of the two compartments of a College poultry house. They were provided with a grassy range about 30 by 12 meters which was divided lengthwise into two parts by a wire netting so that the fowls could be changed from one yard to another as desired, thereby establishing a rotation of yards. The feeds were placed separately in bamboo feeding troughs, and the birds were allowed to eat by the "Cafeteria style," that is, the birds were allowed to select their food and eat all they desired. Feeds were available to the birds all the time. When the birds showed a tendency to go to the same trough all the time the places of the troughs were changed. The changing was necessary about every two days. The feeds were weighed weekly. The weights of the birds were recorded every four weeks.

RESULTS AND DISCUSSION

TABLE II.—*Showing weight of the birds.a*

	Single feed test.	Mash-mixture test.
Number of birds	18	18
	kg.	*kg.*
Average weight at the beginning of experiment	1.36±0 049	1 58±0 068
Average weight at the middle of experiment	1.49±0.061	1.65±0.073
Average weight at the close of experiment	1.69±0.087	1.72±0.074
Gain in weight	0 33±0.100	0.15±0 104

aThe probable errors of the means were computed according to Peter's formula.

In the single feed test the birds made an average gain of 0.33 kilogram in a period of eight weeks, thus showing that they did not underfeed themselves in this case. In the mash-mixture test the birds gained less. This lower gain seems

[2] Ground seed of *Psopocarpus tetragonolobus* L. When young, the pods make very good vegetable human food.

to indicate that the birds relished the feeds in the single feed test more than those in the mash-mixture test.

TABLE III.—*Showing amounts of feed consumed in eight weeks.*

Feeds.	Total amount.	Order of palatability.
Grains	*kg.*	
Corn (cracked)	24.6	2
Rice (rough)	34.9	1
Sorghum (whole grain)	14.2	3
Ground feeds		
Soy beans	3.6	7
Cowpeas	5.1	5
Mungo	9.4	3
Calamismis meal	1.0	8
Rice bran	4.8	6
Copra meal	6.0	4
Blood meal	0.2	9
Dried shrimps	14.7	1
Dried fish	14.1	2

In Table III is shown the total amounts of feeds consumed in the single feed test. As can be seen from this table, rice is the most palatable of the grains used in the test, corn coming next, then sorghum. Among the ground feeds dried shrimps was the most palatable, with dried fish as a close second. This order was based on the weights of the feeds, but in volume the consumption of dried shrimps was greater than that of palay, and dried fish greater than that of corn.

It was observed that on the first day, only the corn, palay, dried fish, and dried shrimps were eaten, all the other feeds remaining untouched. This choice was probably due to the birds being unaccustomed to this method of feeding. Naturally, they rushed to the feeds that they knew best or that were most palatable, leaving the less palatable and unknown feeds alone. In the following three or four days all the feeds in the troughs were consumed except blood meal, soy beans, and calamismis meal which, it may be concluded, were the least palatable. Blood meal was hardly touched at all. During the first week the birds had a natural tendency to rush to the first trough they encountered, and if they happened to like the feed found here, they remained until all of it was consumed, and then passed to the less palatable feeds and ate these in proportion to their palatability. After the first week the birds got over this habit and became accustomed to the feeds and the manner of feeding, and did not rush to any particular feed, but went from one trough to another balancing their rations. Of course the rate of consumption was in proportion to the palatability of the food as is shown in Table III.

All of the provinces produce rice, though in varying quantities. This explains the popularity of this grain as a poultry feed. As it is very palatable, it is one of the most suitable grains in the Islands for poultry feeding.

Corn, though not so extensively raised as rice, because of its wide availability and extreme palatability, is a highly desirable feed for poultry.

Although soy beans and cowpeas are not raised in large amounts there is a fairly good production in most places. These legumes are not so cheap and so palatable as rice and corn, but in places where protein-rich feeds are not available they will supply a fairly good source of protein for poultry feeding.

The palatability tests show that mungo is very palatable. As a source of protein and where it can be raised cheaply it may be highly recommended. Calamismis meal as a poultry feed is not very desirable unless other feeds are not available or when its cost is so low as to warrant its use. In combination with more palatable feeds it is consumed by poultry.

Rice bran is available in almost any part of the Philippines and is especially cheap near rice mills; although it is not very palatable it is recommended as a poultry feed because of its low cost.

Copra meal is a fairly palatable feed for poultry, though of lower rank than rice, corn, sorghum or mungo. Its use should be governed by availability, price, and supply of better feeds.

With regard to blood meal its high price and low rank of palatability make it unprofitable as a poultry feed.

In fishing localities, fish and shrimps are very often thrown away because they are not suitable for human consumption. Because of their high palatability this waste material furnishes an excellent as well as a cheap source of protein for poultry in the Philippines.

TABLE IV.—*Showing amounts of mash consumed in eight weeks.*

Mash-mixtures.	Total amount.	Order of palatability.
	kg.	
No. 1. Rice bran and copra meal	8.90	5
No. 2. Rice bran and blood meal	4.50	8
No. 3. Rice bran and calamismis meal	9.25	4
No. 4. Rice bran and mungo meal	7.60	6
No. 5. Corn meal and copra meal	14.12	2
No. 6. Corn meal and blood meal	4.80	7
No. 7. Corn meal and calamismis meal	13.25	3
No. 8. Corn meal and mungo meal	24.00	1

Table IV shows the amount of feed consumed in the mash-mixture test. It may be seen that the mixtures that had corn meal as the basal part, except No. 6, which was mixed with blood meal, were more palatable than the rice bran mixture, indicating that corn meal is much more palatable than rice bran. Of all the combinations, corn meal and mungo meal are the most palatable. Mash-mixture No. 5, ranked second, and mash-mixture No. 7, third, demonstrating that copra meal and especially calamismis meal which were found not very palatable, become palatable when mixed with corn meal.

Copra meal is not very palatable, but when mixed with some palatable feeds it was also fairly well relished by the birds.

Compared with the other mixtures, blood meal when mixed with rice bran or even corn meal was not very palatable.

As with the single feed test, during the first day the birds consumed only the most palatable mixtures, which were mash-mixture No. 8, mash-mixture No. 5, and mash-mixture No. 3, in their order of palatability. Here, also, this was adjusted as early as the fourth day when all the feeds were partly consumed, but always in relation to their degrees of palatability.

SUMMARY AND CONCLUSIONS

1. The birds made an average gain of 0.33 kilogram in the single feed test and 0.15 kilogram in the mash-mixture test in a period of eight weeks each.

These gains show that the fowls did not underfeed themselves, and that the feeds in the single feed test were more relished than those in the mash-mixture test.

2. Among the grains, rough rice was the most palatable, corn next, and sorghum third. With the ground feeds, dried shrimps was the most palatable, dried fish was a close second, mungo, third, copra meal, fourth, etc. (see Table III).

3. In the first days of the test only the familiar and very palatable feeds were touched. Later, the consumption was in proportion to the palatability, alone, of the feeds. Blood meal was practically untouched.

4. There was greater consumption of mash-mixtures having corn meal as the basic part, than those having rice bran as the basal part. This shows that corn meal is much more palatable than rice bran.

5. The mixture of corn meal and mungo meal was the most palatable, corn meal and copra meal second, etc (see Table IV)

6. Corn meal supplies palatability to certain feed combinations, such as copra meal and calamismis meal, which when fed alone are unpalatable.

7. Mungo, whether single or mixed, is fairly palatable, while blood meal, no matter with what feed it is mixed, is unpalatable.

8. The availability of the feeds in localities and their palatability will determine which can be used profitably for poultry.

RHIZOPUS ARTOCARPI: ITS CULTURAL CHARACTERS AND ITS RELATION TO RHIZOPUS NIGRICANS [1]

By José Crisanto

INTRODUCTION

The male inflorescences and young fruits of the jak-fruit (*Artocarpus integra* (Thunb.) Merr.) are so badly attacked by *Rhizopus artocarpi* Rac. that only a very small percentage of them reach maturity. The disease produced is a soft rot.

In the Philippines the jak-fruit is not cultivated on a commercial scale but is found only in home gardens where little or no attention is given to it, hence the ravages of the fungus are serious.

Reinking, (1) gives a brief description of the symptoms of the disease and its causal organism.

In the present work, studies were made of the behavior of the fungus in the tissues of the host; the morphology of the fungus in culture and in natural infection; and the relation of *R. artocarpi* to *R. nigricans* Ehr.

MORPHOLOGY OF THE FUNGUS

DESCRIPTION OF A FUNGUS MASS OF RHIZOPUS ARTOCARPI FROM JAK-FRUIT

In the first stages of attack on the young inflorescence the fungus appears as a grayish mass which gradually becomes denser forming a black growth with black sporangia protruding. On the edge of the black growth is a whitish fringe of young sporangiophores. The mycelium is abundant over the fruit. The area covered by it rots and in time the whole fruit mummifies and eventually falls off.

The sporangia, which are black and spherical, are borne on the ends of thick, erect, more or less septate branched sporangiophores. They contain numerous spores which are liberated by the bursting of the thin walls of the sporangia when the columellae create sufficient pressure. The spores are somewhat spherical in shape and have a diameter ranging from 8.5 to 13.6 microns. In water culture at room temperature, these spores begin to germinate in about twenty-four hours. At the base of the hyphae, rhizoids are formed which serve for anchorage. These are branched and taper slightly at the ends.

Sections of the infected tissue show that the mycelial threads penetrate both intra-and intercellularly. If sections are stained with alcoholic solution of eosin, the mycelium appears a bright red, and the nuclei and granules are clearly differentiated. They penetrate the entire portions of the infected tissues. The haustoria are club-shaped and taper slightly at the tips. When a hypha penetrates a cell, a constriction is formed. The hyphae do not force their way through by mechanical action but dissolve the cell walls.

[1] Thesis presented for graduation with degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 176. Experiment Station contribution No. 226. Prepared in the Department of Plant Pathology under the direction of Associate Professor Frank P. McWhorter.

DESCRIPTION OF THE FUNGUS GROWTH AND ITS REACTION ON VARIOUS MEDIA

The cultural characters of *Rhizopus artocarpi* were studied on four different media. The observations on the growth were made every twenty-four hours. The date of the inoculations was February 14, 1923.

Litmus milk (2).—Twenty-four hours after inoculation the color of the solution was changed from lilac to white. This change shows that the fungus develops an acid strong enough to react on litmus. The next day (48 hours after inoculation) the medium had coagulated, and a pink coloration had formed on top. So little mycelium was produced that it could not be distinguished in the medium.

Potato cylinders (3).—Twenty-four hours after inoculation, a slight growth was noticed. No sporangiophores were present. After forty-eight hours the growth was still scanty. The next day protruding sporangiophores were visible, and the growth covered the entire cylinder. On the fourth day black sporangia could be seen. Finally the potato cylinder became discolored.

Dextrose solution (4).—Twenty-four hours after inoculation, the solution changed from dark blue to reddish brown, which indicated the presence of acid. The following day the solution became clearer. On top of the solution mycelium and sporangiophores formed.

Potato agar (5).—This medium was used for stock cultures. It was observed that within twenty-four hours after inoculation whitish mycelia and young sporangiophores were visible. The next day a few sporangia appeared black. The mycelia climbed to the sides of the test tubes. The third day sporangiophores bearing black sporangia were evenly distributed throughout the entire medium. The approximate height of the sporangiophores was from four to five millimeters. The medium was not discolored. On the succeeding days the growth became abundant and the surface black. After a month it was observed that the medium turned a light chocolate color but showed no signs of disintegrating.

PHYSIOLOGY OF THE FUNGUS

EFFECT ON THE JAK-FRUIT

Natural infection.—After infection is first evident, it takes an average of four to five days to cover the fruit entirely. The rot usually begins near the stem. Under moist condition the infection advances rapidly. The stem itself is covered by the fungus.

Controlled inoculations.—The fungus develops two days after inoculation with incision and three to four days after inoculation without incision. It takes a day or two to cover the fruit with growth after the infection becomes clearly visible. The characteristic softening of the tissues and the production of sporangiophores with black sporangia take place as in field conditions. This proves the pathogenicity of the fungus. Infection of young fruits may take place through injuries caused by insects or by infection of uninjured fruits.

DISCUSSION OF RESULTS

In natural infection experiments *R. artocarpi* takes four to five days to cover the fruit with growth. The fungus is capable of infecting young healthy fruits.

In controlled inoculations, *R. nigricans* is more virulent than *R. artocarpi*. *R. nigricans* when inoculated through incisions developed signs of infection within twenty-four hours after inoculation; when inoculated without incision it de-

veloped signs of infection within two days. *R. artocarpi* when inoculated through incisions developed signs of infection within two days; when inoculated without incision it developed signs of infection within three to four days.

The growth of the fungus *R. nigricans* on the jak-fruit showed the typical symptoms of the soft rot caused by *R. artocarpi*, but the sporangiophores became more elongated and formed a gray mass as the infection advanced. This gray mass in time developed a few black sporangia. The fruits infected by *R. nigricans* were very different in appearance from those infected by *R. artocarpi*. The growth of *R. nigricans* on the fruit was very irregular, the sporangiophores were comparatively longer, and the black sporangia less numerous than in the case of *R. artocarpi*. Measurements of full grown sporangia of these two species gave an average diameter of 137.2 microns for *R. nigricans* and 155.2 microns for *R. artocarpi*. The spores of *R. nigricans* were smaller and more spherical in shape than those of *R. artocarpi*; they had average diameters of, 7.82 microns and 11.35 microns respectively.

From the measurements given above and the morphological differences, especially septation and general appearance of sporangiophores, it is concluded that *R. nigricans* and *R. artocarpi* are distinct species. Of the two, contrary to expectations, the *R. nigricans* was slightly more virulent than the *R. artocarpi*.

R. nigricans has long been recognized as a wound parasite and the cause of rots in stored fruits and vegetables. In the case of jak-fruit, experiments show that *R. nigricans* can behave as a true parasite and attack the young uninjured fruits while still attached to the tree.

SUMMARY OF CONCLUSIONS

1. Under natural field conditions of infection, the disease became fully developed four to five days after first signs of the disease were evident.

2. *R. artocarpi* grows well on potato agar. In liquid media it produced acid of sufficient concentration to change the litmus indicator present from blue to red.

3. *R. nigricans*, is slightly more virulent in producing jak-fruit rot than is *R. artocarpi*.

4. *R. nigricans* produced the typical symptoms of soft rot caused by *R. artocarpi*. In this case, the species *R. nigricans* behaved as a true parasite.

5. The sporangiophores and mycelium of *R. artocarpi* were more frequently septate, and the sporangia and spores were larger than those of *R. nigricans*. The sporangiophores of *R. nigricans* were longer and formed fewer black sporangia.

6. *R. artocarpi* and *R. nigricans* are two distinct species.

CONTROL

1. Reinking (1) suggests that all diseased inflorescences should be picked and destroyed. Bordeaux mixture may be sprayed in severe cases.

2. Bagging the fruits with cloth or paper at the time of flowering may help to keep the fruits from infection. This is only practicable on a small scale.

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THE COST OF RAISING SWINE UNDER EXISTING CONDITIONS IN THE COLLEGE OF AGRICULTURE[1]

By DANIEL B. PEÑA

WITH ONE CHART

INTRODUCTION

The increase in the number of hogs in the Philippines shows a healthy growth of the swine industry. There were 2,521,143 in 1915 and 3,129,676 in 1919.[2] This increase may be attributed to the general improvement in the prosperity of the country. In spite of this increase in number, however, the Philippines imported swine products to the value of ₱14,371,906 for the seven years 1913-1920.[3] So large an importation shows that there is room for greater improvement in the hog raising industry in this country.

The primary object of this experiment was to find out whether or not hog raising under existing conditions in the College of Agriculture is profitable; the secondary object was to find what relation the proportion of Berkshire blood has to the rapidity of growth of pigs.

The work was begun in August 11, 1920, and ended December 1, 1921, in the College of Agriculture.

MATERIALS AND METHODS

The animals used in this experiment belonged to the Animal Husbandry Department. From the herd of the department the sows that had farrowed were selected. These animals were confined, one sow and its litter in a lot, in the house, till the animals became perfectly tame. Each lot was provided with clean bedding of rice straw or excelsior, a trough and a feed box. Every morning the quarters were cleaned (and at other times if it was necessary) before the swine were fed. At the end of each week the sows, the pigs, and the feeds were weighed.

Usually the pigs became fairly independent of the sows at about nine weeks of age; and at this time they were weaned. The sows were gradually separated from the litters at night and when the pigs became used to the separation it was made complete, by putting the sows with the general herd and the pigs in a lot of their own.

This procedure was repeated several times as the sows did not farrow at the same time. The litters used as specimens were farrowed on August 5, August 11, October 9, October 17, and December 23, 1920, and April 12, June 5, June 17, August 20 (two litters), and September 27, 1921.

[1] Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture, No. 177. Experiment Station contribution No. 227. Prepared in the Department of Animal Husbandry under the direction of Prof. B. M. Gonzales and Prof. E. D. Hester.

[2] Statistical Bulletin No. 3. 89-90. Philippine Bureau of Commerce and Industry, Manila, 1920.

[3] Economic Information Circular No. 1. College of Agriculture, 1922.

As it was the object of the experiment to study conditions as they were no effort was made to keep all the pigs until the end of the experiment. From time to time the pigs were sold as buyers came. The scrub, or undesirable boars were castrated; the good ones were allowed to grow large uncastrated. This selection was made particularly with the seven-eighths Berkshire-litters. When the litters were weaned and the pigs were large enough, they were numbered on the ears and placed in a lot, gilts and barrows together.

Not including the pigs that died, 73 pigs, 9 sows, and 11 litters were used in this study. Two litters from a three-fourths Berkshire-native sow; three litters from two one-half grade Berkshire-native sow; three litters from three native sows; and three other litters from sows of mixed breeding.

From the beginning of the experiment the feed used for the swine was a mixture of rice bran, copra meal, and flint corn. From March 16, 1921, to October 26, 1921, corn became so scarce and expensive that the swine were given a mixture of rice bran and copra meal of the proportion, 1 rice bran to 2 copra meal. Later, on October 27, 1921, the Animal Husbandry Department secured enough corn for the hogs and, again, the former mixture was given. The pigs were weighed generally four hours after feeding, occasionally they were weighed after six hours.

Usually, when the pigs were normal, they began to try to eat after the fourth week, and at the sixth week they were good eaters. A large sized bamboo internode, having the nodes uninjured at both ends, put on a good frame to make it stable, made a serviceable small pig trough. When the sow was so greedy that she interfered with the pigs when eating, a creep was made for the pigs' trough so only the small ones could get to it. At the age of eight weeks the mother was separated every other night from the pigs. The separation was gradually prolonged until the complete separation which occurred about the ninth or tenth week.

GROWTH OF THE ANIMALS

THE EXPERIMENT

Object.—The object of this experiment was to find what relation the intensity of Berkshire blood has to the rapidity of growth of the pigs, when a Berkshire boar is used as a sire to native sows.

Plan.—On August 5, 1920 sow No. 97, one-half grade Berkshire-native, farrowed. From this time up to August 27, 1921, every sow that farrowed was confined in a lot, weighed weekly, including each of the pigs in the litter. Close attention was given in weighing them. For the purpose of comparison, pigs which were 50 per cent Berkshire blood and 50 per cent native, or one-half grade were called Lot I. There were 23 pigs in this lot. Pigs having 75 per cent Berkshire blood and 25 per cent native blood, or three-fourths grade, were called Lot II. There were 21 pigs in this lot. Pigs having 87.5 per cent Berkshire blood and 12.5 per cent native blood, or seven-eighths, were designated as Lot III. There were 13 pigs in this lot. Lot IV consisted of pigs from two native sows bred accidentally by three-fourths grade young boars and from a three-fourths grade gilt bred by a litter mate. There were 16 pigs in this lot. Lot IV was included although it was a mixed lot as the pigs were a part of the herd on which commercial observations were made. Their proportion of Berkshire blood would average about one-half.

Feeding.—For every sow, a feed container, either a box or an empty barrel, was provided. This container was numbered according to the number of the sow. The feed for the particular sow was placed there in quantities calculated to last, at least seven days. Each morning and afternoon the feed for the sow was taken from the container. At the end of the week the remaining feed was weighed and the difference between this and the amount put in the container was recorded as consumed.

To determine how much a sow would eat, a known amount of feed was put in a pail and given to her in the form in which she was accustomed to eat it. She was allowed to eat until satisfied. This was a safe plan for obtaining a quantity basis, otherwise she might have had more food than she could clean up, or she might not have had enough. In the experiment, wet feed was the form most liked by the swine. Feed soaked for several hours before feeding was so bulky that the pigs were not able to eat enough to provide sufficient nourishment. The morning feeding was usually from seven to eight o'clock; clean water was placed in the troughs. When it was necessary to confine the animals the whole day, at noon and in the afternoon, green leaves of ipil-ipil (*Leucaena glauca* Linn.), or camote leaves (*Ipomoea batatas* Linn.), were given. When the swine were free to forage by themselves during the night, then soiling was done only at noon. The pens were cleaned before feeding.

The pigs were given charcoal made from corn cobs mixed with common salt every Wednesday and Saturday.

All the work was performed by the writer. Great care was exercised that the swine received enough feed to perfectly satisfy them. This problem was solved empirically through practice and close observation.

Weighing.—Saturday noon was chosen as the weighing time. When the pigs were from one to three weeks old an empty petroleum box was placed on the balance and the pigs put therein. The box was weighed and accurately recorded and its tare subtracted from the gross to find the net weight. When the pigs became large enough and handling was awkward, a crate on the balances into which each pig was easily driven proved satisfactory.

DISCUSSION OF GROWTH DATA

A summary of the growth data is presented in Table I.

Lot I.—The curve in Chart I representing Lot I, composed of half-grade animals, shows the growth of three litters containing in all, 23 pigs. The sire was pure breed Berkshire boar No. 43 and the dams are indicated in Table II. There were 20 pigs in the lot at the end of the growth observations.

In general the pigs grew normally from birth up to the eighth week, when the sow was gradually separated from the litter. From the eighth to the ninth week the average gain was only two tenths of a kilogram. From the ninth week to the tenth, the pigs having become accustomed to separation from the sow, registered a gain of about six tenths of a kilogram; at this time the separation was made complete and the pigs grew steadily up to the twenty-fourth week, with an average gain of about one kilogram a week.

Lot II.—The data and curve representing Lot II shows the growth of three litters containing 21 pigs possessing 75 per cent Berkshire blood. These animals were from three litters, 13 of which were from two litters born eight months ahead

of the third one. The sire of these animals was also pure breed Berkshire boar No. 43; the dams were one-half grade Berkshire-native. The history of each of these litters is indicated in Table II. The growth of the pigs was normal and rapid. As might be expected there was apparently no set back to the growth of these pigs when they were weaned. One of the first litters consisting of nine pigs was weaned rather early because the dam died of kidney worms. The pigs were fed cow's milk for a time. This lot had 17 pigs at the end of the experiment.

Lot III.—For Lot III, the graph represents two litters of the same dam, farrowed eight months apart, comprising 13 pigs. The dam was three-fourths grade, and the sire of both litters was Berkshire boar No. 43. The pigs carried, therefore, seven-eighths Berkshire blood. They were beautiful animals, refined, docile, and grew fast. Their rapid growth was checked partly when they were weaned. This lot ended with 9 pigs.

Lot IV.—Lot IV is represented by an irregular curve in Chart I. This is to be expected, as the lot was not uniform. The entire lot represents three litters and a total of 16 pigs. Their record ends at 15th week, as the observations ended then. At the time there were 13 pigs in the lot.

In the care, management, and feeding, great care was exercised that all the animals should receive the same treatment. Lot III showed distinct superiority over the other lots throughout the period of observation. Lot II came second, Lot I third, and Lot IV, the last. Not only in the rapidity of growth did Lot III surpass the other lots, but in the quality of the animals as well. The type, conformation, and general make-up of these animals was more Berkshire than native. Lot II was not far behind and there were a few individuals in this lot which could well compete with the best animals in Lot III. In Lot IV, many of the pigs that were from the three-quarters Berkshire gilt, were similar to those with seven-eighths or three-quarters Berkshire blood. The pigs in Lot I were coarser than the pigs in Lots II, and III. But all were certainly better than native pigs in the thickness of the sides, quarters, and backs. Up to 24 weeks the grade pigs gained in weight in direct ratio to the proportion of the Berkshire blood. That is, the more Berkshire blood a grade pig had the more rapid its gain. There is every reason to believe that this assumption might have been generally true, up to the time of complete maturity, if all the boars had been castrated. The boars did not generally gain in weight as rapidly as the barrows or gilts Their restlessness consumes the energy which would normally be utilized in laying on flesh and fat. Although there was a record of growth up to one year in a number of the animals it was deemed best to present the data up to the 24th week only, as after that date many of the pigs either died or were sold. Some kind of selection became operative, therefore, and the figures besides being based on a few animals could not very well be considered as normal.

History of the pigs.—The gestation period of the sows used in this experiment ranged from 111 to 118 days, with an average of 115 days. This period includes from the day of breeding to the day of farrowing. An average of about eight and a half pigs to a litter is the record of the sows used, but due to the high mortality of the young pigs, only about seven pigs (6.6) to a litter were raised, giving 21.5 per cent mortality. A number of the larger pigs died of hog cholera, kidney worms, and lung worms (*Filaria*) and blood poisoning (*septicemia*). The causes of the death of some pigs at birth when the other members of the litter

were perfectly healthy, was unknown. Some pigs were born so small and weak that they did not live longer than a day or two. The cause of this inferiority is also unknown.

All the pigs in this experiment were sired by Berkshire boar, No. 43, imported from the United States, except those from sows Nos. 135, 307 and 309A. Sow 97 was a one-half grade gilt and was the dam of two litters used in the experiment. Sow 88 was 50 per cent Berkshire and 50 per cent native (Jala-Jala). She died of kidney worms when her litter was about seven weeks old. Sow 114 was a three-fourths Berkshire grade. She was the dam of two litters used in this experiment also. Sow 306 was a native (Jala-Jala). She died of hog cholera when she was about to farrow her second litter for the year. The first litter of this sow was used in Lot II. Sows 308 and 309 were native gilts from Los Baños. Sows 307 and 309A were native gilts of poor conformation, thin, small, narrow, and razor-backed. They weighed at the time they were covered about 45 kilograms. Sow 135 was a three-fourths Berkshire. The last three were bred accidentally by herd mates, young three-fourths Berkshire pigs. The dates of their mating, farrowing, and the number of pigs in the litter are all shown in Table II.

MARKETING THE SWINE AND SWINE PRODUCTS

THE EXPERIMENT

Object.—The object of this experiment was to find out whether or not hog raising under existing conditions in the College of Agriculture is profitable.

Materials and plan.—The materials used in this experiment were the same materials used in Experiment One. The work was run concurrently with the growth experiment, but the results cannot be clearly presented except by separating the two different phases involved in the work. Hence, the animal husbandry phase and the economic phase are here treated separately.

It was the primary plan of this experiment to record any phase of work which financially affected the herd under observation; to convert the time spent on the herd into its money equivalent; to add to this the cost of the feed consumed, the cost of the disinfectants used, and the depreciation of the equipment used, and the rent of the land and sows, and depreciation on the sows. The total sum of the items given above was subtracted from the sum of the revenue derived from the sale of the product. The economic experiment was originally supposed to run for only one year, but it was finally decided to prolong it to 16 months in order to make it equal in time to the growth experiment. The desired end of the economic experiment was to show the net gain or loss.

Economy in feeding.—As much economy was practiced in feeding as was consistent with proper nourishment of the swine.

Disposal of the pork.—According to the plan of the experiment the Department of Animal Husbandry of the College, acted as market commissioner paying the writer who was held as primary producer an over-all price which was calculated by the department on the basis of probable salable dressed-out weight; butchering and marketing at 5 per cent of gross receipts; and the expected retail price. Mr. Francisco P. Lago was in charge of the business for the Animal Husbandry Department.

Twenty-three pigs for breeding (with a total live weight of 629.6 kilograms) were sold outright for ₱610.45. This amount was paid directly to the supposed producer. There were sold 48 hogs for meat, total live-weight 1984.7 kilograms.

Two pigs died during the experiment. This accounts for the total of 73 pigs used. Two other pigs were fed with these pigs and their increase during the period was added to the total gain. Their total initial weight was 5.4 kilograms and their weight at the end of the period of observation was 72 kilograms or a net gain of 66.6 kilograms. The total weight of the pigs sold for meat was therefore 2051.3 kilograms.

In nursing the litters the sows lost an aggregate weight of 203.5 kilograms

TABLE III.—*Showing weight of the sows.*

Sows.	No. 88	No. 97	No. 114	No. 306	No. 309	No. 97	No. 114	No. 308	No. 307	No. 309A	No. 135	Total weight.
	kg.	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*
Initial weight...	140	80	140	121	52	78	158	97	60	50.5	103	1079.5
Final weight....	died	67	120	91	50	65	118	77	32	30	86	736
Difference......	140	13	20	30	2	13	40	20	28	20.5	17	343.5

and one sow, weighing 140 kilograms died (see Table III). A total of 343.5 kilograms were, therefore, accounted for as depreciation on sows. As the sows were turned back to the College herd after weaning their pigs, this system of computation was devised, by which the writer as operator assumed the risk of any loss in weight or total loss of the sows through death, by paying the College the actual value as pork, paid a rent of ₱5 a litter of each sow used, and paid a price of ₱2.50 a head for each pig. The pigs were not all actually butchered. At the close of the experiment they were weighed. The breeding pigs mentioned above were practically all sold.

Observations at the College have shown that if the dressed weight of an animal is multiplied by the retail price of pork, one cannot expect to have that return in practice. For example, a pig weighing 100 kilograms dresses 75 per cent, or 75 kilograms. If the retail price of pork is ₱1 a kilogram, one would figure on getting ₱75 from the pig. There are, however, parts of the carcass which cannot be sold at the stated market price, as the head and shanks. There are also losses due to trimmings, shrinkage or drying, etc. These are not fully compensated by the fact that one is able to sell most of the viscera, which are not included in the dressed weight. There is also occasionally some meat remaining unsold towards the end of the day which has to be disposed of at bragain prices. Unpublished data of the Animal Husbandry Department shows that the average return in actual cash is 84 per cent of the dressed weight times the retail price of dressed pork. This is effectively 63 per cent of the live weight. [Live-weight x .75 (dressed-weight) x 84. (salable-weight) = Live-weight x .63] So that in the above example the net return would be .63 x 100 x ₱1 or ₱63.

The retail price of pork at the time, however, was ₱1.20. The 2051.3 kilograms meat sold, netted therefore, (63 per cent x 2051.3 x ₱1.20) ₱1550.78.

RESULTS

From a commercial angle the income and expenditure may be summarized as follows:

(a) *Income*

Sales:	
23 pigs for breeding (629.6 kilograms)	₱ 610.45
50 pigs for meat (2051.3 kilograms)	1,550.78
Gross income	₱2,161.23

(b) *Expenses*

Rent of 1.1 hectares (value ₱165.00) for 1 1/3 years at 12% per annum		26.40
Capital Goods:		
Interest charge on 1 building (value ₱700) for 1 1/3 years at 12% per annum		112.00
Depreciation 10% per annum		93.33
Interest on 640 meters fencing (value ₱440.00) for 1 1/3 years at 12% per annum		70.40
Depreciation at 10% per annum		58.67
Interest on 1 balance (value ₱60.00) for 1 1/3 years 12% per annum		9.60
Depreciation at 3% per annum		2.40
Rent of 9 sows with 11 litters at ₱5.00 per litter		55.00
Depreciation on sows. (343.5 kilograms)		259.69
Labor:		
General labor cost		240.00
Butchering charge		77.54
Supplies:		
1 tin crude oil		1.50
2 bottles creolin		2.76
11 feeding troughs		35.00
Feeds:		
6857.4 kilograms copra meal at average price	₱ 0.04	
3836.8 kilograms rice bran at average price	0.05	545.98
1175.0 kilograms maize at average price	0.07	
Purchases:		
73 pigs at ₱2.50 each		182.50
Expenses		₱1,772.77

(c) *Net income:*

Gross income	₱2,161.23
Expenses	1,772.77
Net income	₱ 388.46

(d) Details of gross income have been arranged in the following lists:

Animals sold for breeding.

	Litter No.	*Weight kg.*	*Income*
Gilt No. 131	88	15.0	₱20.00
Gilt No. 136	88	15.0	20.00
Gilt No. 139	88	21.7	27.00
Gilt No. 130	88	17.7	24.00
Boar No. 140	88	22.7	23.00
Boar No. 142	88	22.0	22.00
Boar No. 134	97	20.0	20.00
Boar No. 144	114	19.6	23.00
Boar No. 149	114	10.8	25.00
Boar No. 145	114	18.7	29.00
Boar No. 150	306	12.9	12.00
Boar No. 151	306	9.9	10.00
Boar No. 132	97	50.0	45.00
Boar No. 133	97	39.0	30.00
Boar No. 147	114	107.0	81.00
Gilt No. 148	114	101.0	75.75
Gilt No. 164	97	26.0	28.00
Gilt No. 165	97	26.0	28.00
Boar No. 175	114	25.0	30.00
Boar No. 187	135	8.0	6.75
Boar No. 188	307	16.6	12.45
Boar No. 189	307	11.0	8.25
Gilt No. 202	135	14.0	10.00
Total		629.6	₱610.45

Animals sold for meat.

	Litter No.	Weight kg.	Income
Gilt No. 141	88	54.0	
Barrow No. 137	88	103.0	
Gilt No. 138	88	120.0	
Gilt No. 135	97	115.0	
Barrow No. 143	114	55.0	
Gilt No. 146	114	93.0	
Barrow No. 152	306	110.0	
Barrow No. 153	306	94.0	
Gilt No. 154	306	67.0	
Gilt No. 155	306	80.2	
Barrow No. 157	309	39.0	
Barrow No. 158	309	78.0	
Gilt No. 160	309	70.0	
Gilt No. 161	309	77.0	
Barrow No. 162	309	83.0	
Barrow No. 163	97	41.0	
Barrow No. 166	97	41.0	
Gilt No. 167	97	41.0	
Gilt No. 168	97	43.5	
Gilt No. 169	97	45.5	
Gilt No. 170	97	43.5	
Gilt No. 701	114	38.0	
Boar No. 172	114	31.0	
Boar No. 173	114	32.0	
Boar No. 174	114	31.0	
Boar No. 176	114	33.0	
Barrow No. 177	308	21.0	
Barrow No. 178	308	26.0	
Barrow No. 179	308	20.5	
Barrow No. 180	308	17.5	
Barrow No. 181	308	25.5	
Barrow No. 182	308	17.5	
Gilt No. 183	308	20.5	
Barrow No. 184	308	20.0	
Gilt No. 185	308	24.0	
Gilt No. 186	308	19.0	
Gilt No. 190	307	10.0	
Gilt No. 191	307	6.5	
Barrow No. 192	309A	12.0	
Gilt No. 193	309A	17.0	
Gilt No. 194	309A	12.0	
Barrow No. 195	309A	11.0	
Barrow No. 196	309A	10.0	
Gilt No. 197	135	8.0	
Gilt No. 198	135	10.0	
Gilt No. 199	135	10.0	
Gilt No. 200	135	8.0	
Gilt No. 201	135	11.0	
Gilt No. 3	net gain	29.6	
Gilt No. 4	net gain	37.0	
	Total	2051.3	₱ 1,550.78

Labor Cost.—The general labor on the project was approximately the half time of a laborer earning ₱30 a month, or ₱15. The experiment lasted 16 months. His wages were therefore ₱240. The butchering and marketing charge was 5 per cent of gross receipts, or ₱77.54.

Feeding Costs.—The prevailing price of corn, rice bran, and copra meal from August 1920 to January 1921 was ₱0.10, ₱0.10, and ₱0.075 per kilogram, respectively. Due to the crisis in 1921 the prices dropped down to ₱0.04, ₱0.04, and ₱0.03. The bulk of the feed was consumed in 1921, since the pigs were rather small at the beginning of the experiment. Retail pork dropped down from ₱1.50 to ₱1.20 at about the same period.

DISCUSSION OF RESULTS

Relation of net income to investment.—Considering the investment to constitute the average between the opening and closing inventories[4] which would be ₱1276.65, the net income, ₱388.46 was 30.5 per cent of the average investment for a period of 1⅓ years or 22.9 per cent per annum.

Conditions affecting net income.—The conditions affecting the net income were four, so far as the writer could account; (1) The equipment was used not only in this experiment but also by the College herd as a whole, hence the depreciation to be charged this experiment could be lower; (2) the swine did not reach maturity so as to realize full benefits; (3) under commercial scale, the writer thinks that the number of pigs raised could be made two times the number used in the experiment without increasing appreciably the capital invested in equipment. On the other hand (4) there was a sudden drop in feed prices to about 40 per cent from the beginning of the experiment until it ended. The price of pork lagged, dropping from ₱1.50 to ₱1.20 a kilogram at the end of the experiment, a reduction to only 80 per cent of the original price. All in all, the conditions for making good profits were probably more favorable in the experiment than at normal times.

Cost of production of one kilogram of pork.—The total live weight of production, including both meat and breeding animals was 2680.9 kilograms. The expenses of production including butchering and marketing charges, were ₱1772.77. The cost reduced was, therefore, ₱0.661 a kilogram of live weight.

The total dressed weight at 75 per cent was 2010.7 kilograms which establishes a cost of ₱0.882 a kilogram of dressed weight.

The total salable weight, 84 per cent of dressed weight was 1689 kilograms which establishes a cost of ₱1.05 a kilogram of salable weight.

SUMMARY AND CONCLUSIONS

GROWTH EXPERIMENT

Litters of pigs, reared under the College of Agriculture, possessing the least intense Berkshire blood gained the slowest; and the litters of pigs having the most intense Berkshire blood gained the most rapidly from birth up to 24 weeks or about six months. The rapidity of growth of Berkshire grade pigs is in direct ratio to the intensity of Berkshire blood. It was observed that boar pigs usually gained in weight less rapidly than gilts or barrows.

ECONOMIC EXPERIMENT

a. Even under existing conditions in the College of Agriculture, where hogs are raised for experimentation, not for gain, the project was profitable when the retail price of pork was ₱1.20 a kilogram. It was found by this experiment that with a capital of ₱1276.65 the College realized a net gain of 22.9 per cent per annum on the investment. Under the account of net income, ₱388.46 was the yield of one and one-tenth hectares of land for 1⅓ years which reduces to ₱265.13 a hectare per annum exclusive of the rent of the land.

b. It was shown above that it cost ₱0.661 to produce a live weight kilogram of pork; hence a year old hog weighing 80 kilograms live weight raised by the College of Agriculture at that time required ₱52.88, and the hog when converted into pork and sold, realized 50.4 kilograms of salable meat which at ₱1.20 a kilogram gave ₱60.48.

c. It was also shown that it required about 5.08 kilograms of feed to produce 1 kilogram gain.

d. That after deducting all costs of operation; rent, feed, labor, interest and depreciation charges, the managerial income of the operator on an investment of ₱1,276.65 for 16 months was ₱388.46 or ₱291.65 per annum.

[4] Inventories on file, Department of Animal Husbandry.

e. Assuming the project to be in charge of a technically trained man, as was the case herein, for instance a college graduate with a family, he should require a managerial income of four times that realized (₱1166.60). To attain this he should need about ₱5000 capitalization and a market for approximately 5100 kilograms of pork per annum at a retail price of not less than ₱1.20 per kilogram. He would have to do his own butchering and marketing as it is scarcely likely that any middleman would handle that end on a five per cent margin. In the latter case his income should be increased correspondingly.

TABLE I.—*Showing weight at birth and average weekly weights thereafter of the pigs used in the experiment.*

	Lot I.			Lot II.			Lot III.			Lot IV.		
	No. of pigs.	Total wt.	Av. wt.	No. of pigs.	Total wt.	Av. wt.	No. of pigs.	Total wt.	Av. wt.	No. of pigs.	Total wt.	Av. wt.
		kg.	*kg.*		*kg.*	*kg.*		*kg.*	*kg.*		*kg.*	*kg.*
At birth...	23	17.70	.769	21	18 555	.883	13	13.2	1.02	16	15.0	.93
1 wk....	23	31.42	1.366	21	39.2	1.86	13	25 5	1.96	16	25.7	1.60
2 wk.....	23	50.00	2.17	21	55.3	2.68	13	37.4	2.87	16	43.8	2.73
3 wk....	23	66.1	2.87	21	67.95	3.23	13	50.8	3.90	16	61.3	3.83
4 wk.....	23	81.5	3.54	21	79.9	3.80	13	61.4	4.72	16	74.5	4.65
5 wk.....	22	93.4	4.24	21	97.1	4.62	13	77.3	5.94	16	83.5	5.21
6 wk.....	22	112.9	5.13	21	116.4	5.54	13	90.3	6 94	16	90 5	5 65
7 wk.....	22	121.9	5.54	21	140.3	6 68	13	110.2	8.47	16	97.8	6.11
8 wk.....	22	139.3	6.33	21	150.4	7.16	13	126.1	9.70	16	102 0	6.37
9 wk.....	22	150.6	6.84	21	184.4	8.78	13	130 0	10.00	16	109.5	6.84
10 wk.....	22	163.0	7.40	21	196.9	9.38	13	152 4	11 72	16	117.6	7 35
11 wk.....	22	177.5	8.06	21	217.2	10.34	12	148.5	12 70	16	123.3	7.70
12 wk.....	22	198.4	9.01	21	231.0	11.00	12	156.6	13.05	16	139.1	8 69
13 wk.....	22	216.9	9.76	21	246.6	11.74	12	164 8	13.73	15	144.3	9 62
14 wk.....	22	233.0	10.59	21	276.0	13.13	12	178.4	14 86	13	126.5	9 73
15 wk.....	22	255.1	11.59	21	291.7	13.90	12	192.5	16.04	End of Experiment		
16 wk....	22	269.6	12.25	21	312.6	14.40	11	186.2	16.92			
17 wk.....	21	277.5	13.21	21	331.5	15.78	11	202.9	18.44			
18 wk.....	21	309 6	14.74				10	198.1	19.81			
19 wk.....	20	319.2	15.96		*a*		9	192.3	21 36			
20 wk....	20	336.5	16 82	20	386 2	19.31	9	207.3	23.03			
21 wk....	20	351.4	17.57	20	424 3	21 21	9	222.1	24.67			
22 wk.....	20	367.9	18.36	20	444.5	22 23	9	231 0	25.66			
23 wk.....	20	387.6	19.38	19	444 5	23.40	9	242.2	26.91			
24 wk ...	20	426.8	21.34	17	446 2	26.25	9	251.2	27.91			

a One litter not weighed for 2 weeks.

TABLE II.—*Presenting history of the litters.*

Sows.		Date mated.		Date forrowed.		Period of gestation.	No. of pigs farrowed.		No. of pigs dead or very weak at birth.		Pigs used in experiment.	
No.	Kinds.						Male.	Female.	Male.	Female.	Male.	Female.
97	1/2	April	14	Aug.	5	113	3	2	—	1	3	1
88	1/2	April	17	Aug.	11	116	6	6	1	2	5	4
114	3/4	June	15	Oct.	9	116	4	3	—	—	4	3
306	N	June	25	Oct.	17	114	4	6	—	3	4	3
309	N	Sept.	2	Dec.	23	112	4	2	—	—	4	2
97	1/2	Dec.	20	April	12	113	3	6	1	—	2	6
114	3/4	Feb.	9	June	5	116	5	5	1	3	4	2
308	N	Feb.	23	June	17	114	6	4	—	—	6	4
307*a*	N	April	26	Aug.	20	116	3	4	1	2	3	1
309*a*	N	April	26	Aug.	20	116	3	4	1	1	2	3
135*a*	3/4	April	30	Aug.	26	118	2	8	1	2	1	6
Totals—(Average)						115	43	50	6	14	38	35

a Accidental mating, young boars broke through the fence to sows.

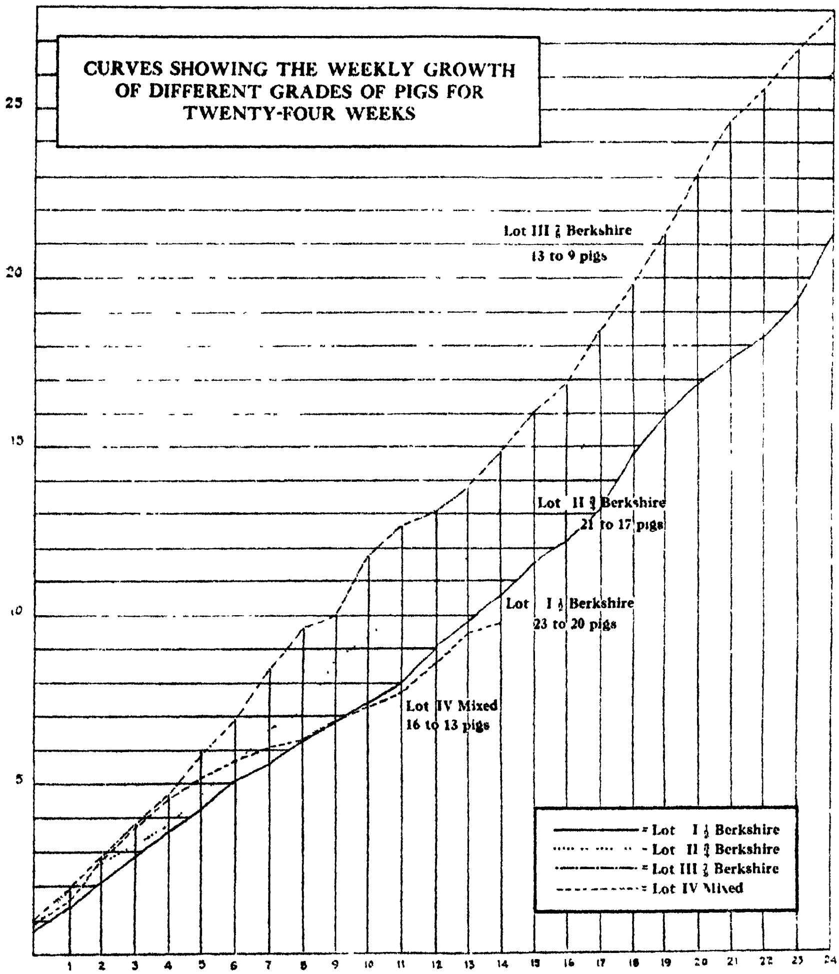

Chart 1.—Growth curves.

RELATION OF THE COLLEGE OF AGRICULTURE TO LOWER SCHOOLS[1]

By Evett D. Hester
Registrar, College of Agriculture

WITH ONE TEXT FIGURE

The College of Agriculture of the University of the Philippines has from its date of establishment been burdened with the problem of articulation of its curricula with a constantly expanding number and increasing complexity of lower school curricula. The problem has been made more difficult by the necessity of keeping the upper end of the curricula of the College (the upper end being indicated by the degree of Bachelor of Science in Agriculture) in equivalency with like curricula in colleges of agriculture in the United States. This necessity is not subject herein to critical analysis. It is a University, even a national, educational standard. The College itself has no voice either in decreeing the general standard of American agricultural colleges, or in altering radically the University policy of equivalency therewith. This policy we may dismiss as a constancy.

That the College of Agriculture has successfully maintained this "upper end" articulation, is proved by the fact that it has been ranked "A" by American universities and by the less arbitrary and more essential test that many Bachelors of Science from the College of Agriculture have transferred to American universities for graduate work and none have experienced difficulty in earning their Master's degrees in one year and their Doctorates in three years.

This articulation has been maintained in the face of inadequate funds; a rapidly shifting foreign faculty; the necessity, through a system of government foreign scholarships, of rapidly substituting a permanent Filipino faculty of high attainments; a negligible background of tropical agricultural knowledge involving the precedence of heavy research for each step in the teaching of each technical course; the early necessity of creating a dignity of labor against an adverse social psychology; and frequent lack of sympathy from higher authorities. That it has been accomplished is a near-miracle and a monument to two men such as other founders and pioneers may envy.

The present paper is, however, particularly concerned with the "lower end" articulation—the relation of the College of Agriculture to lower schools. Colleges of liberal arts and of the ancient professions and, in the United States, colleges of agriculture as well, have merely set up as entrance requirement the completion of the standard high school course as evidenced either by accreditation or examination. Adjustments for a few "conditioned" students who have failed in one subject in the final year of their high school curriculum has represented the maximum burden of lower-end articulation which such colleges have borne.

With the College of Agriculture the case has been far different and less facile. From the beginning of the institution several conditions were obvious: (a) The

[1] General contribution from the College of Agriculture No. 113.

high school as constituted on a belletristic basis was by no means the best preparation for the Bachelor of Science in Agriculture curriculum; (b) The youth of the Islands were enamoured with the classics and "learned professions" naturally, as they had, for three hundred years been more or less effectively ostracised from these ambitions; (c) The high schools tended to wean their students away from the soil; (d) Largely the sons of the less prosperous element of the country sought agriculture as a vocation and were unable to capitalize the conventional eight year (high school and college) regimen above their elementary schooling; (e) The first primary English-speaking schools opened to an enrollment averaging over ten years of age which placed the early intermediate (elementary, or grammar) school graduates at seventeen or eighteen years of age, when in consonance with the relative early maturity and high mortality of the race it was inefficient to postpone bread-winning for eight more years. (f) A student in any one of the four years of the high school would suddenly experience what psychologists might term a "vocational shock" and immediately wish to undertake technical agriculture, luckily there were no vocational analysts to confuse his selection. (g) Considering all causes, it was patent that there were not enough high school graduates who would appreciate the advantages of technical agriculture to give the College the numerical weight necessary for the justification of its existence.

Finally, the question resolved itself into the possibility of taking intermediate school graduates, putting them through a six year curriculum and turning them out as competent, technically, as their more favored brothers who would have spent eight years, four in high school and four in college, to attain the same practical end. If this could be done most of the problems outlined in the paragraph above would be solved; if not, merely another and useful educational experiment would have been written. "The proof of the pudding being in the eating thereof," the first Dean accepted the challenge and the College opened to two groups of student:

Group I.—High school graduates who would immediately undertake a four-year technical agricultural curriculum.

Group II.—Intermediate school graduates who would undertake two years of preparatory work in lieu of high school and then join the first group for a practically identical four-year technical agricultural curriculum.

For honesty, policy, and correlation with foreign standards, Group I, the high school graduates, were to be given the degree Bachelor of Science in Agriculture and Group II, the intermediate school graduates, were to be given the modified degree, Bachelor of Agriculture. From the fact that both groups were to complete a full four-year technical course, it would be unjust to give the second group merely a diploma as they were to accomplish actual degree work. It was, however, expedient to modify terminology sufficient to avoid confusion and to serve as a signal that Group II were different from Group I in educational experience.

Thus at the very beginning a broad policy was established; first, to facilitate lower-end articulation it was made easy to get into the College; and secondly, to retain upper-end articulation and general standards it was made difficult to get through the College. Later, scholarship rules of a strict type were established to make it difficult to remain in the College and to furnish the necessary check to the broad entrance policy.

The experiment worked, and as we are all pragmatists at heart, that is sufficient apology. The policies have been continued to this hour. The lateral flexibility of entrance has been increased so that the records of the Registrar's Office show the receipt of students from every type of intermediate school—general, trade, industrial, and farm—; from every type of high school—general, normal, commercial, trade, and agricultural—and transfers from every type of college and special school with the exception of nautical, military, fine arts, and music. And from each type of high school have come students from every year thereof. From this complexity of source have arisen graduates of precisely equal technical knowledge who have taken co-ordinate positions in after life and have maintained them with equal success. The accomplishment stands as one of the most notable illustrations of economy in education in the present Philippine system.

The only substantial difference between Group I, Bachelor of Science in Agriculture, and Group II, Bachelor of Agriculture, is that the latter have studied neither Myer's *History of Europe*, nor the *Literature of England from Chaucer to Kipling*. There are those, who, because of this deficiency in belles lettres would eliminate the "six year course" on the general basis that it "looks bad". Significantly, the detractors are those who have not been in personal contact either with the working of the broad entrance system at the College or with the two classes of graduates. In the light of the necessity for early improvement of the agricultural resources of the Philippine Islands, why strain at the Chaucerian gnat? It would be interesting, profitable, and perhaps final to submit several successive classes of both groups of graduates to modern psychological tests.

A graphic representation of the educational experience of the two general groups of students to which the College has accommodated itself is presented in Figure 1.

THE FOUR REGULAR CATEGORIES

It is the first object of this paper to describe the four regular categories of students including their elementary, secondary, and collegiate training.

ELEMENTARY CURRICULUM

All categories of students pass through the four year primary and three intermediate schools of the Philippine system. The subject content of these schools will not be considered. The primary schools are of one sort, while intermediate schools offer attempts at vocationization in farm, trade, and household arts. For entrance into the College of Agriculture, the character of intermediate curricula has been ignored. In Figure 1, two groups, Group I and Group II are led equally from the primary through and out of the intermediate brackets.

SECONDARY CURRICULA

The usual student of the College of Agriculture has experienced one of two types of secondary education. Following the indicated line in Figure 1, it will be found that Group I enters the four-year high school and Group II enters the two-year preparatory curriculum of the College of Agriculture. It will be profitable to compare these two types of secondary education in detail.

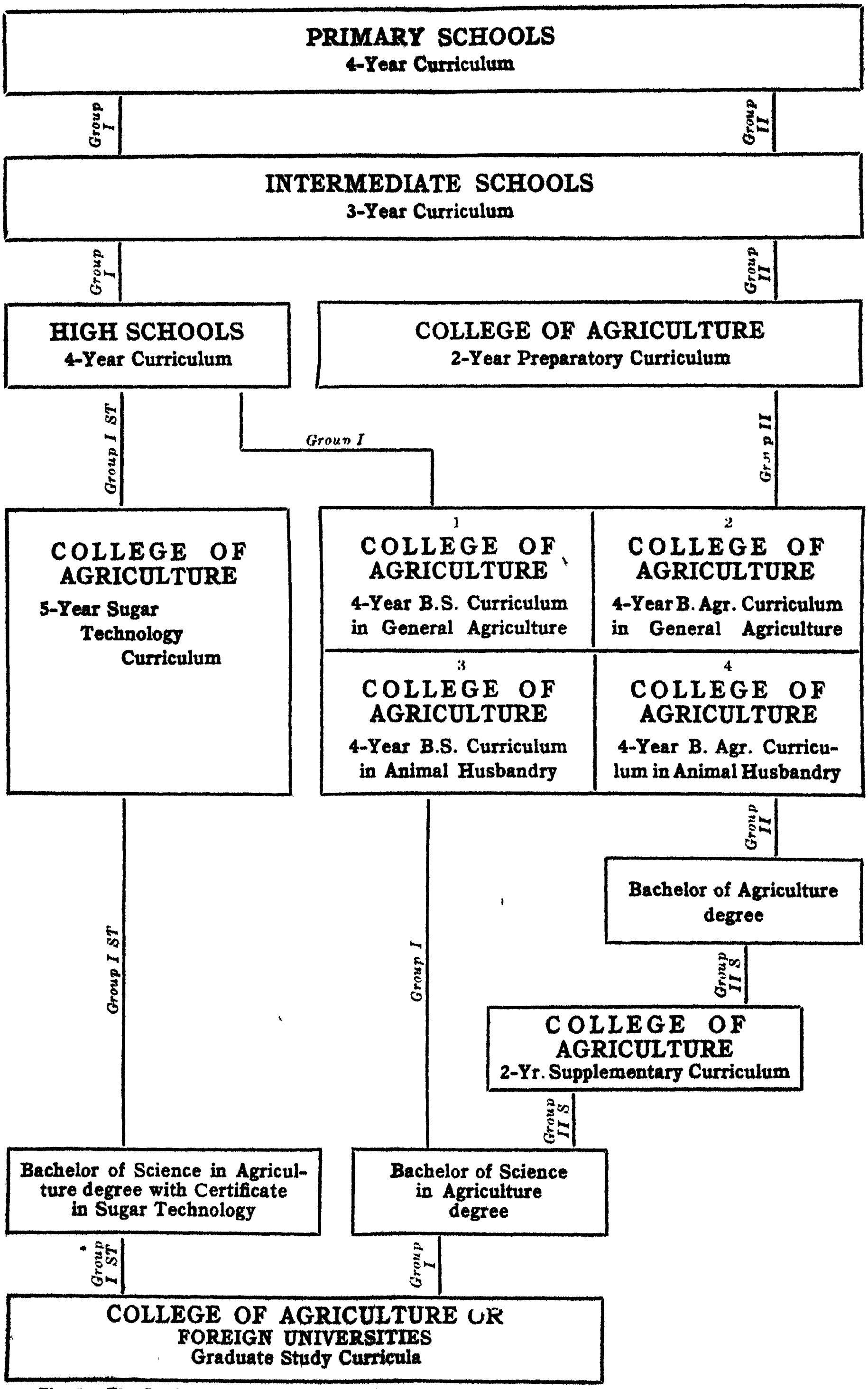

Fig. 1.—The Curricula of the College of Agriculture, University of the Philippines, and their relation to lower schools.

The general high school curriculum.—The general high school curriculum as prescribed for public and private secondary schools in the Philippines by the Department of Public Instruction is presented in Table I.[3]

TABLE I.—*General curriculum of Philippine High Schools.*

Year.	Subject.	Semesters.	Periods a week.*a*	Units.*b*
First	English Composition I	Both	5	10
	English Literature I.	Both	4	8
	Current Events I	Both	1	2
	United States History	Both	3	6
	United States Government	Both	2	4
	Elementary algebra	Both	5	10
	Military drill	Both	2	*c*
	Group games and athletics.	Both	3	*c*
Second	English composition II	Both	2	4
	English literature II	Both	3	6
	Physical geography	Both	5	10
	General history I	Both	4	8
	Current events II	Both	1	2
	Plane geometry	Both	5	10
	Military drill	Both	2	*c*
	Group games and athletics	Both	3	*c*
Third	English composition III	Both	2	4
	English literature III	Both	3	6
	Biology (botany and zoology)	Both	5D*d*	10
	General history II	Both	4	8
	Current events III.	Both	1	2
	Advanced algebra	First	5	5
	Review arithmetic.	Second	5	5
	Military drill	Both	2	*c*
	Group games and athletics	Both	3	*c*
Fourth	English composition IV	Both	2	4
	English literature IV	Both	3	6
	Economic conditions	Both	5	10
	Philippine history and government	Both	4	8
	Current events IV	Both	1	2
	Physics	Both	5D*d*	10
	Military drill	Both	2	*c*
	Group games and athletics	Both	3	*c*
All	All subjects			160

a Periods are of 40 minutes duration unless otherwise noted.
b One period a week for one semester equals one unit.
c Informal credit.
d D indicates double or laboratory period of 80 minutes duration but equivalent to one regular period in unit value.

3 From the Office of the Director, Bureau of Education.

The preparatory curriculum.—The outline of the two-year preparatory curriculum of the College is presented in Table II.[3]

TABLE II.—*Preparatory curriculum of the College of Agriculture.*

Year.	Subject.	Semesters.	Periods a week.a	Units.b
First......	English 1, *Composition*....................	Both	5	10
	Mathematics 1, *Elementary algebra*....................	Both	5	10
	Plant physiology 1, *Elementary botany*....................	Both	2+2Tc	8
	Agronomy 1, *Field practice*....................	Both	2Tc	4
	Rural economics 1, *Economic conditions*....................	Both	2	4
	Military science 1....................	Both	3	*d*
	Physical training 1....................	Both	1	*d*
Second....	English 2, *Composition*....................	Both	5	10
	Mathematics 2, *Plane geometry*....................	Both	5	10
	Physics 1....................	Both	2+1Tc	6
	Zoology 1....................	Both	3+2Tc	10
	Military science 2....................	Both	3	*d*
	Physical training 2....................	Both	1	*d*
Both....	All subjects....................	....	....	72

a Periods are of 55 minutes duration unless otherwise noted.
b One period a week for one semester equals one unit.
c T indicates triple or laboratory period of 175 minutes duration but equivalent to one regular period in unit value.
d Informal credit.

Comparison of academic subjects.—Considering the academic content of the two curricula—high school and two-year preparatory—and the difference in length of periods, a detailed comparison on a clock-hour basis, classified according to general subject matter, is given in Table III.

In further explanation of the comparison presented in Table III, it may be said that: (a) Mathematics 1 (*Elementary algebra*) in the College of Agriculture covers algebra and a part of advanced algebra in the high school, using the same text books; (b) Mathematics 2 (*Plane geometry*) covers the entire text which is only partially covered by plane geometry in the high school; (c) Plant Physiology 1 is practically a full year course in elementary botany in place of the first half of biology in the high school; (d) Zoology 1 is a full year course in place of the second half of biology in the high school; (e) Physics 1 covers the work of physics in the high school using the same text but effecting a saving in clock-time through small laboratory and quiz sections (10 to 15 students to the section); and (f) Rural Economics 1 covers the same field as economic conditions in the high school using the same basic text (Miller's *Economic Conditions of the Philippines*) but saving clock-time by small quiz sections (10 students to the section).

[3] From University of the Philippines Bulletin No. 10, page 356.

TABLE III.—*Comparison of the preparatory curriculum of the College of Agriculture, University of the Philippines, with the general curriculum of the high schools under the Philippine Bureau of Education.*

High school general curriculum.				College of agriculture preparatory curriculum.			
Subjects and courses.	Year.	Credits.a	Clock hours.b	Equivalent subjects and courses.	Year.	Credits.c	Clock hours.b
English Composition:				English Composition:			
Composition I	1	10	107	English 1	1	10	147
Composition II	2	5	53	English 2	2	10	147
Composition III	3	5	53				
Composition IV	4	5	53				
All composition		25	266	All composition		20	294
English Literature:				English Literature:			
Literature I	1	8	85	Not given.			
Literature II	2	5	53				
Literature III	3	5	53				
Literature IV	4	5	53				
All literature		23	244				
Current events:				Current events:			
Current events I	1	2	21	Not given.			
Current events II	2	2	21				
Current events III	3	2	21				
Current events IV	4	2	21				
All current events		8	84				
History:				History:			
United States history	1	6	64	Not given.			
United States government	1	4	43				
General history	2	8	85				
General history	3	8	85				
Philippine history	4	8	85				
All history		34	362				
Mathematics:				Mathematics:			
Algebra	1	10	107	Mathematics 1 (*Algebra*)	1	10	147
Plane geometry	2	10	107	Mathematics 2 (*Plane geometry*)	2	10	147
Advanced algebra	3	5	53				
Review arithmetic	3	5	53				
All methematics		30	320	All mathematics		20	294
Science:				Science:			
Physical geography	2	10	107	Agronomy 1	1	4	184
Biology (*Botany and zoology*)	3	10	213	Plant Physiology 1 (*Elementary botany*)	1	8	243
Physics	4	10	213	Zoology 1	2	10	293
				Physics 1	2	6	152
All science		30	533	All science		28	872
Economics:				Economics:			
Economic Conditions	4	10	107	Rural economics 1 (*Economic conditions*)	1	4	59
All subjects		160	1916	All subjects		72	1519

a A high school credit is taken as 40 minutes a week for 16 weeks in classroom or 80 minutes a week for 16 weeks in laboratory.
b Clock hours here given represent the actual time during the school year devoted to the subject.
c A College credit is taken as 55 minutes a week for 16 weeks in classroom or 175 minutes a week for 16 weeks in laboratory or field.

The inspection of Table III permits the following conclusions on the comparison of the co-ordinate courses:

(1) The College of Agriculture preparatory curriculum covers effectively the high school general curriculum except for literature, history, and current events—in short, it covers all the essentials of preparation for technical higher education.

(2) The College preparatory curriculum devotes slightly more time to English composition than does the high school general curriculum.

(3) The College preparatory curriculum devotes much more time to science than does the high school general curriculum.

(4) The College preparatory curriculum is "two years" in name and in over-all duration only, and not in substance, as it covers 80 per cent as much work on a clock-hour basis as does the four-year high school general curriculum.

(5) There can be no doubt but that the preparatory student in the College is forced to more rapid work and a greater number of hours of study for each day than is the high school student. The general plan of allowing an hour for home, library, and study-room preparation for each hour of class room or laboratory attendance, enables a computation which will bring out evidence on this point. Each of the 32 school weeks in the College includes six "study-days" or a total of 192 such days for each school year. This gives 384 study-days for the College preparatory student during his two years. Each of the 32 school weeks in the high school includes five study-days or a total of 168 such days for each school year. This gives 640 study-days for the high school student during the four years. The College preparatory curriculum requires 1519 class room or laboratory hours and an equal number of preparation hours—a total of 3038 or an average of about 8 hours for each study-day of the two years. The high school general curriculum requires 1916 class room or laboratory hours and an equal number of preparation hours—a total of 3832 hours or an average of almost 6 hours for each study-day of the four years.

The greater pushing might be criticised as too heavy a load for immature students to which is opposed the considerations that: (a) The medical officer attached to the College staff has found a remarkably high average health among the students; (b) The average age of preparatory students in the College is greater than the average age of high school students, although the latter age four years during attendance against two years for the former, a fact which would tend to increase the average age of high school students; (c) Greater mental maturity in the College preparatory student, regardless of age, is evidenced by the fact that he has passed into or through the "vocational shock"; (d) College preparatory students are able to proceed more rapidly in the class room due to the fact that they form a more selective group than the high school students, for, from a population of 11,000,000, there were approximately 30,000 high school students for the school year 1922-1923,[4] whereas there were but 200 agricultural preparatory students, and while the high schools promoted over 80 per cent of their students[4] the College promoted less than 60 per cent of its preparatory students.

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[4] Twenty-third Report of the Director of Education.

THE COLLEGIATE CURRICULA

Referring again to Figure 1, following the line for Group I, it is found that upon leaving the high school the group splits into two sub-groups—Group I and Group I ST—for purposes of entrance into the College of Agriculture.

The curriculum in sugar technology.—Group I ST enters the five-year curriculum in sugar technology offered by the College and leading to the degree of Bachelor of Science in Agriculture with Certificate in Sugar Technology and permitting subsequent candidacy for Master of Science in Agriculture. The sugar technology curriculum consists of 176 units of work and two semesters of sugar mill practice. The fact that dynamics and calculus, which are included in the sugar schedule, demand a lengthy prerequisite sequence of mathematics, makes it impossible to articulate the sugar curriculum with the two-year preparatory, hence it is open only to those who have come through high school. Inasmuch as this curriculum is not involved in differential articulation with lower schools, present consideration of it may be dismissed.

The four-year curricula.—Group I, having come via the high school route, and Group II, having come via the preparatory route enter together the four-year curricula of the College of Agriculture. (See Figure 1.) There are four four-year curricula in the College which are arranged in both vertical and horizontal juxtaposition. The vertical juxtaposition holds for entrance and degree, that is: (1) and (3) are open to Group I, the high school graduates, and lead to the degree of Bachelor of Science in Agriculture; while (2) and (4) are open to Group II, the preparatory graduates, and lead to the degree of Bachelor of Agriculture. The horizontal juxtaposition holds for specialization, that is; (1) and (2) offer identical specialization in general agriculture, regardless of entrance or degree; while (3) and (4) offer identical specialization in animal husbandry, regardless of entrance or degree.

Comparison of Bachelor of Science and Bachelor of Agriculture general curricula.—In the introduction and again in the above paragraph, the practical identity of the Bachelor of Science and Bachelor of Agriculture curricula has been emphasized. The proof of this identity is developed in Table IV, wherein the identities are shown in plain type and the few differences, in black-faced type.

Explanations of the differences may be briefly given: (a) The preparatory graduate takes Mathematics 3 (*Advanced algebra*), 5 units, which is not required of the high school graduates who covered the subject in the third year of the high school. The presence of this subject in the Bachelor of Agriculture curriculum is admittedly an extension of work of a preparatory nature into the collegiate schedule. (b) The preparatory graduate takes English 3a (*Composition*), 5 units, which is not required of the high school graduate. This is also an extension of work of a preparatory nature into the collegiate schedule. (c) The preparatory graduate takes his collegiate composition under the designation, English 3b, 5

units, while the high school graduate takes his collegiate composition under the designation, English 4, 5 units. These two courses are to all intents and purposes the same, representing a pragmatic division of the two groups. (d) The high school graduate takes Agronomy 1 (*Field practice*), 4 units, which has already been covered by the preparatory graduate. As this course is distinctly elementary it may be taken as an extension of work of a preparatory nature into the collegiate schedule. (e) The high school graduate takes Zoology 1 (General), 10 units, which has already been covered by the preparatory graduate. This course would not be required of high school graduates were it not for the fact that the average high school course in biology is practically useless as a foundation for the intensive application of the biological sciences found in the agronomy, plant pathology, entomology, and animal husbandry divisions. The same argument might be made for the other half of high school biology—botany—as it will be noticed that the high school graduate is released from Plant Physiology 1 (*Elementary botany*) of the preparatory schedule. This inadequacy was at one time recognized and the high school graduate compelled to enter the College in the summer session prior to his freshman year for the purpose of relieving an "automatic condition" in botany. So much dissatisfaction resulted from this requirement that the plan was dropped and it is now left for those sections of Plant Physiology 2 which have high school graduates to informally remedy the shortcomings of their students in elementary botany. This compromise could not be made for the zoological end as no second course in zoology is provided in the collegiate schedules.

Summarizing the comparison between the Bachelor of Science in Agriculture, and Bachelor of Agriculture general curricula, it is apparent that the Bachelor of Science in Agriculture curriculum is composed of 164 units of work, of which 14 units (Agronomy 1 and Zoology 1) represent intrusion of preparatory work into the collegiate schedule, and 150 units represent the technical agricultural collegiate schedule. Similarly, it is apparent that the Bachelor of Agriculture curriculum is composed of 160 units of work, of which 10 units (Mathematics 3 and English 3a) represent intrusion of preparatory work into the collegiate schedule, and 150 units represent the technical agricultural collegiate schedule.

Finally, excepting the variant designation of the two courses in collegiate English Composition (English 4 in Bachelor of Science, and English 3b in Bachelor of Agriculture), the 150 technical collegiate units of the Bachelor of Science general curriculum and the 150 technical collegiate units of the Bachelor of Agriculture general curriculum *are identical.*

No apology for the intrusion of secondary material (the 14 units in Bachelor of Science, and the 10 units in Bachelor of Agriculture) need be made. The cause is the insufficient or the inapplicable character of the average high school work in biology which, although accepted for entrance, is not suitable for foundation of technical agriculture. And, while the high school graduate is removing his 14 units of informal "conditions," the preparatory graduate strengthens his preparatory mathematics and English by an additional 10 units, thus keeping the 150 collegiate units parallel for Bachelor of Science and Bachelor of Agriculture, both in sequence and chronologically.

Total technical units.—The total of 150 technical units required for the degrees Bachelor of Science in Agriculture and Bachelor of Agriculture, is greater than the number of units required for the Bachelor of Science degrees in other schools and colleges of the University of the Philippines, as is indicated in the following lists:

Curricula of the University	*Units*
Bachelor of Science in Agriculture	150
Bachelor of Agriculture	150
Bachelor of Science in Commerce	147
Bachelor of Science in Mechanical Engineering	145
Bachelor of Science in Civil Engineering	144
Bachelor of Science in Library Science	136
Bachelor of Science in Government	132
Bachelor of Science in Education	132
Bachelor of Science in Home Economics	126

Comparison of Bachelor of Science and Bachelor of Agriculture animal husbandry curricula.—To this point the discussion has centered on, and Table IV has presented, a comparison of the Bachelor of Science curriculum in general agriculture with the Bachelor of Agriculture curriculum in general agriculture, brackets (1) and (2) in Figure 1. Similar comparison of the Bachelor of Science curriculum in animal husbandry with the Bachelor of Agriculture curriculum in animal husbandry, brackets (3) and (4) in Figure 1, might be made with the following results:[5] (a) The differences between the Bachelor of Science animal husbandry and the Bachelor of Agriculture animal husbandry curricula are exactly the same as the differences between the Bachelor of Science general and Bachelor of Agriculture general curricula; (b) 150 units of the technical collegiate work in the Bachelor of Science animal husbandry and Bachelor of Agriculture animal husbandry schedules are identical, but differ considerably from the 150 units the two general curricula; (c) The first year collegiate of the Bachelor of Science general and the first year collegiate of the Bachelor of Science animal husbandry curricula are identical; and (d) The first year collegiate of the Bachelor of Agriculture general and the first year collegiate of the Bachelor of Agriculture animal husbandry curricula are identical.

SUPPLEMENTARY CURRICULUM

In Figure 1, Group I is further traced to its degree, Bachelor of Science in Agriculture, Group I ST, to the same degree with the addition of a Certificate in Sugar Technology, which degrees are articulated at the upper end with graduate study looking towards the degree Master of Science in Agriculture. At this point, both Group I and Group I ST may be dismissed.

Turning to Group II, it has been traced to its degree, Bachelor of Agriculture. This award is a true degree and not a diploma, due to the important consideration that the technical experience (the 150 hours in either specialization) of the Bachelor of Agriculture curriculum has been identical with that of the Bachelor of Science curriculum. The modification in nomenclature, as was suggested in the introduction, is to avoid confusion and to serve as a signal to those institutions, here and abroad, who hold rigidly to an eight years regimen supra elementary (four years secondary plus four years collegiate) as prerequisite to graduate work.

[5] For details of technical work in the animal husbandry schedules, see University of the Philippines Bulletin No. 10, pages 353 and 358.

TABLE IV.—*Comparison of the Bachelor of Science Curriculum (for high school graduates) and the Bachelor of Agriculture Curriculum (for preparatory graduates) of the College of Agriculture, University of the Philippines.*

[Identical subjects in plain type, differences in black-faced type.]

Bachelor of Science General Curriculum. *(For High School Graduates)*

Courses.	1st sem. units.	2nd sem. units.
First year collegiate:		
English 4 (*College Composition*)	5	
Mathematics 5 (*Trigonometry*)		3
Plant Physiology 2 (*Second Botany Course*)	4	4
Agricultural Chemistry 1 (*General*)	5	5
Rural Economics 2 (*Rural Economy*)	3	3
Agronomy 1 (*Field Practice*)	2	2
Agronomy 2 (*Agricultural Geology*)	3	
Agronomy 3 (*Soils*)		5
All courses	22	22
Second year collegiate:		
Zoology 1 (*General*)	5	5
Agricultural Chemistry 2 (*Analytical*)	5	5
Rural Economics 3 (*Farm Accounting*)	2	2
Physics 2 (*College Physics*)		5
Agronomy 4 (*Principles of Production*)	5	
Agronomy 5 (*Survey of Production*)	5	
Agronomy (*Elective*)		5
All courses	22	22
Third year collegiate:		
Entomology 1 (*General*)	5	
Plant Pathology 1 (*General*)		5
Agronomy (*Elective*)	5	5
Rural Engineering 1a (*Mechanics*)	4	
Rural Engineering 1b (*Farm Machinery*)		3
Rural Engineering 1c (*Surveying*)		1
Major	5	5
All courses	19	19
Fouth year collegiate:		
Animal Husbandry 1 (*General*)	4	4
Elective	5	5
Major	10	10
All courses	19	19
All years	82	82

Bachelor of Agriculture General Curriculum. *(For Preparatory Graduates.)*

Courses.	1st sem. units.	2nd sem. units.
First year collegiate:		
Mathematics 3 (*Advanced Algebra*)	5	
Mathematics 5 (*Trigonometry*)		3
Plant Physiology 2 (*Second Botany Course*)	4	4
Agricultural Chemistry 1 (*General*)	5	5
Rural Economics 2 (*Rural Economy*)	3	3
Agronomy 2 (*Agricultural Geology*)	3	
Agronomy 3 (*Soils*)		5
All courses	20	20
Second year collegiate:		
English 3a (*Composition*)	5	
English 3b (*College Composition*)		5
Agricultural Chemistry 2 (*Analytical*)	5	5
Rural Economics 3 (*Farm Accounting*)	2	2
Physics 2 (*College Physics*)		5
Agronomy 4 (*Principles of Production*)	5	
Agronomy 5 (*Survey of Production*)	5	
Agronomy (*Elective*)		5
All courses	22	22
Third year collegiate:		
Entomology 1 (*General*)	5	
Plant Pathology 1 (*General*)		5
Agronomy (*Elective*)	5	5
Rural Engineering 1a (*Mechanics*)	4	
Rural Engineering 1b (*Farm Machinery*)		3
Rural Engineering 1c (*Surveying*)		1
Major	5	5
All courses	19	19
Fourth year collegiate:		
Animal Husbandry 1 (*General*)	4	4
Elective	5	5
Major	10	10
All courses	19	19
All years	80	80

Origin.—It was originally thought that the small number of graduates of the College whom it would be desirable to send to institutions of higher learning abroad would come largely from the Bachelor of Science curricula. But almost from the very beginning, the Bachelor of Agriculture curricula produced the greater number of candidates for higher technical specialization, the more obvious cause for this being their preponderant number of the total enrollment. Some universities in the United States—Wisconsin, Johns Hopkins and Chicago among them—were willing to accept the Bachelor of Agriculture graduate with his acknowledged shortage of two years' work in preparatory literature and history as candidates for Master's degrees. However, as the number of candidates for Master's degrees from this and other colleges of the Philippine Islands increased, there was a tendency to tighten entrance to candidacy. When the University of the Philippines established its own Master's system it ruled against the Bachelor of Agriculture graduates. It became necessary to remedy a condition which barred a select but important few of the Bachelors of Agriculture from higher degrees.

Composition.—The task of formally preparing Bachelors of Agriculture for Master's work was accomplished by carrying a selected few of Group II, who are designated in Figure 1 as Group II S, through a supplementary curriculum which is composed as follows:

Subject Groups.	*Units.*
History electives	20
English literature and higher composition electives	10
Optional academic electives	20
Optional academic or technical electives	10
All subjects	60

The work normally takes two years and, upon satisfactory completion, the degree of Bachelor of Agriculture is raised to the degree of Bachelor of Science in Agriculture, thus removing the barrier to candidacy which exists under present standards of graduate study.

The College offers several academic courses for the supplementary schedule, as follows:

Courses.	*Units.*
History 1 (General history of Europe)	10
History 2 (American history)	5
History 3 (Federal and Insular government)	5
History 4 (Philippine history)	5
History 5 (Oriental history)	5
English 11 (Advanced collegiate composition)	6
English 12 (English literature)	5
English 13 (General literature,	6
French 1 (Beginning French)	6
French 2 (Intermediate French)	6
German 1 (Beginning German)	6
German 2 (Intermediate German)	6
Spanish 1 (Beginning Spanish)	6
Spanish 2 (Intermediate Spanish)	6
All courses	83

From these 83 units the student in the supplementary curriculum selects at least 50 units and from any of the scientific and technical courses which he has not presented for the Bachelor of Agriculture degree, he may select not more than 10 units. With the consent of the Dean of the College, the supplementary curriculum may be pursued in any accredited high school or in the classical colleges, provided always that the student working in the supplementary curriculum shall not present for credit subjects duplicating in substance any of the subjects offered for the degree of Bachelor of Agriculture.

From the standpoint of theoretical pedagogy, the supplementary curriculum may not be altogether defensible. However, it aptly meets a situation which could not be avoided. The vigor, intelligence, and success with which mature men undertake their delayed experience in the liberal arts, throws doubt upon some precedents in modern education. The number of students admitted to the supplementary curriculum is very limited. It will be perceived at once that it represents an effort—so far, very successful—to maintain upper end articulation in spite of the broad entrance policy.

THE FARM EXPERIENCE CURRICULUM

To avoid confusion, no mention has been made of the curriculum in farm experience which occupies one long recess (8 to 10 weeks); is required of all undergraduate students, except those specializing in sugar technology, (Group I ST); and is composed as follows:

Subject.	*Hours a week.*
Farm experience A (*Seasonal practice*)	15
Farm experience B (*Blacksmithing*)	9
Farm experience C (*Carpentry*)	9
All subjects	33

The work is usually taken by the high school graduates, Group I, during the recess between first and second collegiate years and by the intermediate school graduates, Group II, during the recess between first and second preparatory years. The curriculum is a common factor and does not effect the entrance regulations.

SUMMARY OF REGULAR CATEGORIES

Thus far four regular categories of students have been taken through their educational experience to their respective degrees. They may be summed up as follows:

Group I:—Primary school (4 years); Intermediate school (3 years); General high school (4 years); College of Agriculture curricula with specialization in either general agriculture or animal husbandry including the farm experience curriculum (4 years); Granted the degree of *Bachelor of Science in Agriculture;* Prepared for graduate study.

Group I ST:—Primary school (4 years); Intermediate school (3 years); General high school (4 years); College of Agriculture technical curriculum in sugar technology (5 years); Granted the degree of *Bachelor of Science in Agriculture* with *Certificate in Sugar Technology;* Prepared for graduate study.

Group II:—Primary school (4 years); Intermediate school (3 years); College of Agriculture preparatory and farm experience curricula (2 years); College of Agriculture technical curricula with specialization in either general agriculture or animal husbandry (4 years); Granted the degree of *Bachelor of Agriculture;* Not generally admitted to graduate study.[6]

[6] Whether or not Group II is prepared for graduate study is a matter of opinion.

Group II S:—Primary school (4 years); Intermediate school (3 years); College of Agriculture preparatory and farm experience curricula (2 years); College of Agriculture technical curricula with specialization in either general agriculture or animal husbandry (4 years); Granted the degree of *Bachelor of Agriculture;* College of Agriculture (or elsewhere) supplementary curriculum (2 years); Granted the degree of *Bachelor of Science in Agriculture;* Prepared for graduate study.

Of these groups, the bulk of the students form Group II; about 20 per cent form Group I; about 4 per cent form Group II S; and less than 2 per cent form Group I ST.

Group II S has produced the greater number of pensionados whose successful higher education has enabled the building up of a Filipino faculty—perhaps the most important task during the first decade of the existence of the College of Agriculture.

SPECIAL CATEGORIES

Under *The Four Regular Categories* the articulation of the College was with the completion of the four year *general* high school course (Groups I and I ST) and with the completion of the intermediate school (Groups II and II S). Since the establishment of the College there has been an elaboration of secondary curricula in the Philippine system in the way of agricultural, normal, trade, and commercial high schools. These special high schools are reckoned as vocational ends in themselves and the authorities of the Bureau of Education have never encouraged the output of such institutions to undertake university work. Nor has the College itself intentionally influenced their graduates to shift. Nevertheless, graduates of special schools are applying in increasing numbers for admission to the College. In harmony with the broad entrance policy, these are allowed to enter under certain conditions. The graduates of each of these special schools must be conditioned in one or more subjects and consequently they form special categories.

In addition to articulation with special high schools, the College has encountered an ever increasing number of students who have completed one or more years, but have not graduated from the high school. That high schools in the Philippines are over-crowded; that they are located one in each provincial capital whither the students from outside the capital must travel and where they must pay in board and lodging as much if not more than in living at the College of Agriculture; that the students of the general high schools maintain certain fictitious and expensive standards of living, especially in clothing and social affairs, which are notably absent at the College; that there are exceptional opportunities for partial self-support at the College which do not exist in any except the agricultural high schools; that the College is manned by instructors, even in its preparatory curriculum of far higher attainments than the instructors of the average high school; that the College is a college and has the prestige of being a part of the one and only state university of the Islands, a prestige shared by the preparatory as well as collegiate classes; and perhaps more frequently than one might credit, that the student while in high school makes his genuine vocational choice —all these facts are reasons for the shifting from third, second, and first years of high schools to the College.

There are those who would check what they term "uneconomic shifting" by denying admission of the "shifters" to the College. But the faculty of the College think otherwise. They assume a hands-off policy because; (a) Perhaps

a delayed vocational choice is more sound than a previous immature one; (b) Greater human waste may result from refusing aid in rectifying an alleged mistake in vocational choice than in permitting re-education; and (c) No impediment, however slight, should be placed in the way of agricultural education in a country emphatically agricultural in interest.

GENERAL HIGH SCHOOL CATEGORIES

Completion of general high school.—Graduates of general high schools form Groups I and I ST of the regular categories described above.

Completion of third year.—Students who have completed with satisfactory ratings the third year in general high schools form Group I 3 and are admitted to the Bachelor of Science curriculum conditioned in Rural Economics 1, and Physics 1,

Group I 3 should complete the Bachelor of Science curriculum in five years.

Completion of second year.—Students who have completed with satisfactory ratings the second year of general high schools form Group I 2 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. Subjects.	*H. S. units.*	*Credited in C. A. as*	*C. A. units*
English composition I	10	English 1	10
Algebra	10	Mathematics 1	10
English composition II	10	English 2	10
Plane geometry	10	Mathematics 2	10

Group I 2 should complete the preparatory curriculum in one year, after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. If subsequently, any of these students desire to work in the supplementary curriculum, thus forming Group I 2S, they are given advanced standing therein as follows:

H. S. Subjects.	*H. S. units.*	*Credited in C. A. as*	*C. A. units.*
English literature I	8	Supplementary English	10
Current events I	2		
United States history	6	Supplementary history	20
United States government	4		
General history I	8		
Current events II	2		
Physical geography	10	Supplementary academic	10

Group I 2S should complete the supplementary curriculum, thereby attaining the degree Bachelor of Science in Agriculture, in one year.

Completion of first year.—Students who have completed with satisfactory ratings the first year of general high schools form Group I 1 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. Subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition I	10	English 1	10
Algebra	10	Mathematics 1	10

Group I 1 should require the usual two years to complete the preparatory curriculum after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. If subsequently, any of

these students desire to work in the supplementary curriculum, forming Group I 1S, they are given advanced standing therein as follows:

H. S. Subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English literature I	8	Supplementary English	10
Current events I	2		
United States history	6	Supplementary history	10
United States government	4		

Group I 1S should complete the supplementary curriculum, thereby attaining the degree of Bachelor of Science in Agriculture, in one year.

AGRICULTURAL HIGH SCHOOL CATEGORIES

The Bureau of Education has established several secondary courses in agriculture which aim through empirical teaching of the arts of husbandry to hasten settlement of the great unplowed domain. These schools were designed as vocational entities and it was not expected that their graduates would go further in their education. Inevitably, a few of their brighter graduates have wished to undertake scientific agriculture in the College. Moreover, some of the students of these special schools in the lower years have shifted. In general, the students coming from agricultural high schools to the College have represented an exceptionally valuable source of entrance material, being firm in their vocational choice, "broken" to the soil, and equipped with a valuable, if non-technical, introduction to agriculture.

These schools are commonly termed "of the Muñoz type" after the town of Muñoz, Nueva Ecija, where the first and most noted of the agricultural high schools is located. The curriculum of these schools is outlined in Table V.[7]

To the proper articulation of the foregoing curriculum with the curricula of the College of Agriculture, no little time was given. Several committee and conference sessions were held both at Muñoz and Los Baños. There was no difficulty in accepting graduates or students from Muñoz in the preparatory curriculum at the College, but the authorities at Muñoz, overlooking for the moment the fact that their school is a vocational entity and not a university preparatory school, could see no reason why students so well trained in agriculture should require six years to attain the Bachelor of Agriculture degree at the College when graduates of general high schools who have been "weaned away from the soil" should require but four years to attain the Bachelor of Science degree.

The real reason lay in the fact that although the Muñoz student had taken horticulture, farm management, field crops, animal husbandry, farm engineering, etc., subjects exactly similar in name to the technical subjects of the College, these subjects had not been preceded by mathematics and the fundamental sciences. For this reason they were entirely dogmatic in their content, whereas similarly titled work at the College is critical in content and intimately bound up with basic natural and biological sciences. The Muñoz student had not had the three year sequence of mathematics (algebra and plane geometry) and physics which fits the student entering the technical curricula of the College to immediately undertake chemistry and plant physiology as a basis for scientific agriculture. And the general high school graduate had completed precisely this important mathematico-physical sequence which is the accepted *sine quo non* of technical instruction. Hence, while the agricultural high school as constituted might admirably prepare boys for the transcendant purpose of becoming homesteaders of limited areas, and while it might turn out finely charactered, hard working graduates, it could not in any sense specifically prepare for scientific or technical agriculture.

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[7] From the Office of the Director, Bureau of Education, Manila.

TABLE V.—*Curriculum of Philippine agricultural high schools.*

Year.	Subject.	Periods a week.a	Units.b
First	English I	5	10
	Farm arithmetic	5	10
	Horticulture or Farm engineering I	5	10
	Physical education	2	c
	Field work I	24d	10
Second	English II	5	10
	Civic biology	5De	10
	Animal husbandry or Farm engineering II	5	10
	Physical education	2	c
	Field work II	24d	10
Third	English III	1	10
	Farm entomology	5De	10
	Farm crops or Farm management I or Farm engineering III	5	10
	Physical education	2	c
	Field work III	24d	10
Fourth	English IV	5	10
	Farm physics	5De	10
	Extension work or Farm management II or Farm engineering IV	5	10
	Physical education	2	c
	Field work IV	24d	10
All	All subjects		160

a Periods are of 40 minutes duration, unless otherwise noted.
b One period a week for one semester equals one unit. All subjects in this curriculum hold for the entire year.
c Informal credit.
d Arbitrarily, 2.4 hours in the field is here taken as equal to one unit.
e D indicates double or laboratory period of 80 minutes duration but equivalent to one regular period in unit value.

The College had no desire to "steal" the graduates of Muñoz nor to discourage them from re-education in technical agriculture, provided they cared to make the sacrifice of time which conditions necessitated. On the other hand, Muñoz authorities were highly desirous of sending a nucleus of graduates to the College that they might return as instructors—realizing that although their own courses could be taught empirically, they should be taught not by empiricists but by technologists.[8]

[8] See Report of President's Committee on Co-ordination between the College of Agriculture and the Central Luzon (Muñoz) Agricultural School. Los Baños, 1922.

Arrangements for articulation were effected in 1922 and stand as follows:

Completion of agricultural high school.—Graduates of agricultural high schools form Group III and are admitted to the Bachelor of Science curriculum conditioned in Mathematics 1, 2, and 3, and Physics 1, but with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units*
Horticulture	10	Agronomy 1	4
Field work I	10	Farm experience A Farm experience B Farm experience C	Informal

Group III should complete the Bachelor of Science curriculum in five years by taking maximum advantage of summer sessions.

Completion of third year.—Students who have completed with satisfactory ratings the third year of agricultural high schools form Group III 3 and are admitted to the Bachelor of Science curriculum conditioned in Mathematics 1, 2, and 3, Physics 1, and Rural Economics 1, but with advanced standing as in the case of graduates forming Group III. They also should complete the Bachelor of Science curriculum in five years.

Completion of second year.—Students who have completed with satisfactory ratings the second year of agricultural high schools form III 2 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English I	10	English 1	10
English II	10	English 2	10
Civic biology	10	Plant physiology 1	8
Horticulture	10	Agronomy 1	4
Field work I	10	Farm experience A Farm experience B Farm experience C	Informal

Group III 2 should complete the preparatory curriculum in one year, after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. If subsequently, any of these students desire to work in the supplementary curriculum, forming Group III 2S, they are given advanced standing therein as follows:

H. S. subject.	*H. S. units.*	*Credited as*	*C. A. units*
Farm arithmetic	10	Supplementary academic	10
Field work II	10	Supplementary technical	10

Group III 2S should complete the supplementary curriculum, thereby attaining the degree Bachelor of Science in Agriculture, in one year.

Completion of first year.—Students who have completed with satisfactory ratings the first year of agricultural high schools form Group III 1 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English I	10	English 1	10
Horticulture	10	Agronomy 1	4
Field work I	10	Farm experience A Farm experience B Farm experience C	Informal

Group III 1 should require the usual two years to complete the preparatory curriculum, after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. If subsequently, any of these students desire to work in the supplementary curriculum, forming Group III 1S, they are given advanced standing therein as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units*
Farm arithmetic	10	Supplementary academic	10

Group III 1S should require the usual two years to complete the supplementary curriculum, thereby attaining the degree Bachelor of Science in Agriculture.

COMMERCIAL HIGH SCHOOL CATEGORIES

In recent years the Bureau of Education has established a commercial curriculum in several high schools. The subject matter of this curriculum is shown in Table VI.[9]

Students, both graduates and under-graduates from the commercial high schools have entered the College. The curriculum differs in the third and fourth years from the general high schools, particularly in omitting advanced algebra, biology, and physics. In consequence, special categories were set up as described below.

Completion of commercial high school.—Graduates of commercial high schools form Group IV and are admitted to the Bachelor of Science curriculum conditioned in Mathematics 3, Plant Physiology 1, and Physics 1, but without advanced standing. The group should complete the curriculum in four years by taking maximum advantage of summer sessions.

Completion of third year.—Students who have completed with satisfactory ratings the third year of commercial high schools form Group IV 3 and are admitted to the Bachelor of Science curriculum conditioned in Mathematics 3, Plant Physiology 1, Physics 1, and in Rural Economics 1, but without advanced standing. The group should complete the curriculum in five years by taking maximum advantage of summer sessions.

Completion of second or first years.—The first two years of the commercial high schools being identical with the first two years of the general high schools, transfers from the first or second years commercial are treated in the same manner as transfers from the first or second years general. (See pages 498-99).

[9] From the Office of the Director, Bureau of Education.

TABLE VI.—*Curriculum of Philippine commercial high schools.*

Year.	Subject.	Semesters.	Periods a week.a	Units.b
First......	English composition I..................	Both	5	10
	English literature I......................	Both	4	8
	Current events I.........................	Both	1	2
	United States history.....................	Both	3	6
	United States government............. ...	Both	2	4
	Elementary algebra.......................	Both	5	10
	Military drill.......................	Both	2	c
	Group games and athletics....	Both	3	c
Second....	English composition II.....	Both	2	4
	English literature II.............	Both	3	6
	Physical geography.	Both	5	10
	General history I........	Both	4	8
	Current events II.........	Both	1	2
	Plane geometry	Both	5	10
	Military drill	Both	2	c
	Group games and athletics..	Both	3	c
Third . . .	Business English I....	Both	4	8
	Readings I	Both	1	2
	General history II....	Both	4	8
	Current events III....	Both	1	2
	Commercial geography........	First	5	5
	Commercial arithmetic.....	Second	5	5
	Stenography I or Bookkeeping I	Both	5	10
	Penmanship and Typewriting I	Both	4	8
	Spelling I	Both	1	2
Fourth....	Business English II...............	Both	4	8
	Readings II and Current events IV	Both	1	2
	Economic conditions................	Both	5	10
	Commercial law and Business methods	Both	5	10
	Stenography II or Bookkeeping II or Both	Both	5	10
	Typewriting II and Spelling II	Both	5	10
All.......	All subjects............................	....	....	180

a Periods are of 40 minutes duration.
b One period a week for one semester equals one unit.
c Informal credit.

SECONDARY TRADE SCHOOL CATEGORIES

One of the strongest secondary institutions in the Philippine system is the Philippine School of Arts and Trades located in Manila. This school operates a special curriculum. Several of the provincial schools, notably those of Cebu and Leyte, also maintain secondary trade schools.

The subject matter of the secondary trade schools is given in Table VII.[10] Details of the academic subjects only are given in Table VII, as the technical drafting, shop, and woodwork courses are of no special interest to the College of Agriculture, except as a basis for advanced standing in Farm experience B (*Blacksmithing*) and C (*Carpentry*) which is granted every student transferring from secondary trade schools regardless of the specific nature of his technical shop work.

TABLE VII.—*Curriculum of secondary trade schools.*

Year.	Subject.	Semesters.	Periods a week.*a*	Units.*b*
First	English composition I	Both	5	10
	English literature I.	Both	5	10
	Elementary algebra	Both	5	10
	Shop work I	Both	*c*	*c*
Second	English composition II	Both	2	4
	English literature II	Both	3	6
	General history	Both	5	10
	Plane geometry	Both	5	10
	Shop work II	Both	*c*	*c*
Third	English composition III	Both	2	4
	English literature III.	Both	3	6
	Mechanics	Both	5	10
	Advanced algebra	First	5	5
	Review arithmetic	Second	5	5
	Shop work III	Both	*c*	*c*
Fourth	English composition IV	Both	2	4
	English literature IV	Both	3	6
	Physics	Both	5	10
	Solid geometry	First	5	5
	Trigonometry	Second	5	5
	Shop work IV	Both	*c*	*c*
All	All academic subjects			120

a Periods are of 40 minutes duration.
b One period a week for one semester equals one unit.
c Periods and credits not detailed. Reader is referred to Bureau of Education Bulletin No. 43.

The College has found it necessary to list special categories for students transferring from these schools and from various years thereof, as follows:

[10] From Bureau of Education Bulletin No. 43. 1917.

Completion of secondary trade schools.—Graduates of secondary trade schools form Group V and are admitted to the Bachelor of Science curriculum conditioned in Plant Physiology 1, but with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
Solid geometry	5	Mathematics 6	3
Trigonometry	5	Mathematics 5	3
Shop work I	Informal	Farm experience B Farm experience C	Informal

Group V should complete the Bachelor of Science curriculum in four years.

Completion of third year.—Students who have completed with satisfactory ratings the third year of secondary trade schools form Group V 3 and are admitted to the Bachelor of Science curriculum conditioned in Plant Physiology 1, Physics 1, and Rural Economics 1, but with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
Shop work I	Informal	Farm experience B Farm experience C	Informal

Group V 3 should complete the Bachelor of Science curriculum in five years.

Completion of second year.—Students who have completed with satisfactory ratings the second year of secondary trade schools form Group V 2 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition I	10	English 1	10
Elementary algebra	10	Mathematics 1	10
Shop work I	Informal	Farm experience A Farm experience B	Informal
English composition II English literature II	4 6	English 2	10
Plane geometry	10	Mathematics 2	10

Group V 2 should complete the preparatory curriculum in one year, after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. If subsequently, any of these students desire to work in the supplementary curriculum, thus forming Group V 2S, they are given advanced standing therein as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English literature I	10	Supplementary English	10
General history	10	Supplementary history	10
Shop work II	Informal	Supplementary technical	10

Group V 2S should complete the supplementary curriculum, thereby attaining the degree Bachelor of Science in Agriculture, in one year by taking maximum advantage of summer sessions.

Completion of first year.—Students who have completed with satisfactory ratings the first year of secondary trade schools form Group V 1, and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition I	10	English 1	10
Elementary algebra	10	Mathematics 1	10
Shop work I	Informal	Farm experience B Farm experience C	Informal

Group V 1 should require the usual two years to complete the preparatory curriculum after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. If subsequently, any of these students desire to work in the supplementary curriculum, thus forming Group V 1S, they are given advanced standing therein as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English literature 1	10	Supplementary English	10

Group V 1S, should require the usual two years to complete the supplementary curriculum, thereby attaining the degree Bachelor of Science in Agriculture.

TWO-YEAR NORMAL SCHOOL CATEGORIES

There are a limited number of two-year normal school courses in the provincial secondary schools of the Philippines. The curriculum is given in Table VIII.[11]

TABLE VIII.—*Curriculum of two year normal schools.*

Year.	Subjects.	Semesters.	Periods a week.*a*	Units.*b*
First	English composition I	Both	5	10
	English literature I	Both	4	8
	Current events I	Both	1	2
	United States history	Both	3	6
	United States government	Both	2	4
	Advanced arithmetic	Both	5	10
	Industrial work	Both	2+3Dc	10
	Music	Both	2	4
	Physical education I	Both	3	6
Second	English composition II	Both	2	4
	English literature II	Both	3	6
	Advanced reading	Both	5	10
	Psychology	First	5	5
	Methods	Second	5	5
	Physical geography	First	5	5
	Advanced geography	Second	5	5
	Observation and teaching	Both	5Dc	10
	Physical education II	Both	3	6
Both	All subjects			116

a Periods are of 40 minutes duration unless otherwise noted.

b One period a week for one semester equals one unit

c D indicates double or laboratory period of 80 minutes duration but equivalent to one regular period in unit value.

[11] From the Office of the Director, Bureau of Education, Manila.

Completion of two-year normal courses.—Students who have completed the two-year normal course form Group VI 2 are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition I	10	English 1	10
English composition II	4	English 2	10
English literature II	6		

Group VI 2 should require the usual two years to complete the preparatory curriculum, after which they may enter the Bachelor of Agriculture general curriculum which they should complete in the regular four years. If subsequently, any of these students desire to work in the supplementary curriculum, thus forming Group VI 2S, they are given advanced standing therein as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English literature 1	8	Supplementary English	10
Current events	2		
United States history	6	Supplementary history	10
United States government	4		
Advanced arithmetic	10	Supplementary academic	30
Advanced reading	10		
Physical geography	5		
Advanced geography	5		

Group VI 2S lack only 10 units of supplementary history. If their collegiate scholarship is good, they may be permitted in their last year of the Bachelor of Agriculture curriculum to take History 1 (General history) 10 units, in addition to their regular work, thus completing the supplementary curriculum simultaneously with the Bachelor of Agriculture curriculum, in which case they will be given the one degree, Bachelor of Science in Agriculture.

Completion of the first year.—Students who have completed with satisfactory ratings the first year of the two-year normal course form Group VI 1 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition I	10	English 1	10

Group VI 1 should require the usual two years to complete the preparatory curriculum, after which they may enter the Bachelor of Agriculture curriculum, which they should complete in the regular term of four years. If subsequently, any of these students desire to work in the supplementary curriculum, thus forming Group VI 1S, they are given advanced standing therein as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English literature I	8	Supplementary English	10
Current events I	2		
United States history	6	Supplementary history	10
United States government	4		
Advanced arithmetic	10	Supplementary academic	10
Industrial work	10	Supplementary technical	10

Group VI 1S should complete the supplementary curriculum, thereby attaining the degree Bachelor of Science in Agriculture, in one year.

FOUR-YEAR NORMAL SCHOOL CATEGORIES

There are several four year normal school courses in the provincial secondary schools of the Philippines. The curriculum is given in Table IX.[12]

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12 From the Office of the Director, Bureau of Education.

TABLE IX.—*Curriculum of the four-year normal schools.*

Year.	Subjects.	Semesters.	Periods a week.a	Units.b
First......	English composition I....................	Both	5	10
	English literature I..........................	Both	4	8
	Current events I..........................	Both	1	2
	United States history......................	Both	3	6
	United Stated government................	Both	2	4
	Advanced arithmetic.......................	Both	5	10
	Industrial work..........................	Both	3Dc	6
	Drawing................................	Both	2Dc	4
	Physical education I.......................	Both	3	6
Second....	English composition II..................	Both	2	4
	English literature II.......................	Both	3	6
	Advanced reading..........................	Both	5	10
	General history I..........................	Both	4	8
	Current events II..........................	Both	1	2
	Physical geography........................	First	5	5
	Advanced geography......................	Second	5	5
	Elementary algebra........................	Both	5	10
	Physical education II.......................	Both	3	6
Third.....	English composition III..................	Both	2	4
	English literature III.....................	Both	3	6
	Biology..................................	Both	5Dc	10
	General history II.......................	Both	4	8
	Current events III........................	Both	1	2
	Psychology.............................	First	5	5
	General methods..........................	Second	5	5
	Music..................................	Both	3	6
	Writing.................................	Both	2	4
	Observation.............................	Both	3	6
Fourth....	English composition IV..................	Both	2	4
	English literature IV......................	Both	3	6
	Economic conditions......................	Both	5	10
	Philippine history and government.........	First	4	4
	Current events IV........................	First	1	1
	Physiology, hygiene, and sanitation.........	Second	5	5
	School management.......................	First	5	5
	History of education.....................	Second	5	5
	Observation and teaching II..............	Both	5Dc	10
	Physical education III....................	Both	3	6
All.......	All subjects..............................	....	....	224

a Periods are of 40 minutes duration unless otherwise noted.
b One period a week for one semester equal one unit.
c D indicates double or laboratory period of 80 minutes duration but equivalent to one regular period in unit value.

Completion of the four-year normal course.—Graduates of the four-year normal course form Group VII and are admitted to the Bachelor of Science curriculum conditioned in Mathematics 2, and 3 and Physics 1. They should complete the curriculum in five years.

Completion of the third year.—Students who have completed with satisfactory ratings the third year of four-year normal schools, form Group VII 3 and are admitted to the Bachelor of Science curriculum conditioned in Mathematics 2 and 3, Physics 1, and Rural Economics 1. They should complete the curriculum in five years.

Completion of the second year.—Students who have completed with satisfactory ratings the second year of the four-year normal schools, form Group VII 2 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition I	10	English 1	10
English composition II	4	English 2	10
English literature II	6		
Elementary algebra	10	Mathematics 1	10

Group VII 2 should require one year to complete the preparatory curriculum, after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. All students in Group VII 2 are registered during their fourth year of the Bachelor of Agriculture curricula in the supplementary curriculum, thus forming, also, Group VII 2S. They are given advanced standing in the supplementary curriculum as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English literature I	8	Supplementary English	10
Current events I	2		
United States history	6	Supplementary history	20
United States government	4		
General history I	8		
Current events II	2		
Advanced arithmetic	10	Supplementary academic	20
Physical geography	5		
Advanced geography	5	Supplementary technical	10
Industrial work	6		
Drawing	4		

The advanced standing scheduled above amounts to the entire requirement of the supplementary curriculum with the result that Group VII 2S automatically completes the supplementary curriculum simultaneously with the Bachelor of Agriculture curriculum and are consequently recommended for the one degree, Bachelor of Science in Agriculture.

Completion of the first year.—Students who have completed with satisfactory ratings the first year of the two-year normal course form Group VII 1 and are admitted to the preparatory curriculum with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition I	10	English 1	10

Group VII 1 should require the usual two years to complete the preparatory curriculum, after which they may enter the Bachelor of Agriculture curriculum,

which they should complete in the regular term of four years. If subsequently, any of these students desire to work in the supplementary curriculum, thus forming Group VII 1S, they are given advanced standing therein as follows:

H. S. subjects.	*H. S. units.*	*Cerdited as*	*C. A. units.*
English literature I	8	Supplementary English	10
Current events I	2		
United States history	6	Supplementary history	10
United States government	4		
Advanced arithmetic	10	Supplementary academic	10
Industrial work I	6	Supplementary technical	10
Drawing	4		

Group VII 1S should complete the supplementary curriculum, thereby attaining the degree Bachelor of Science in Agriculture in one year.

PHILIPPINE NORMAL SCHOOL CATEGORIES

Without doubt, the strongest secondary course given in the Philippine Islands is that provided in the Philippine Normal School, an Insular institution located in Manila. The College of Agriculture, itself, was an outgrowth of this institution. The Philippine Normal School provides three curricula: (a) The academic course; (b) The home economics course; (c) The supervising teachers and principals course. The College of Agriculture articulates only with the academic course and that alone will be considered here. The academic course requires completion of the first year of the general high school curriculum for entrance—hence the entire course may be taken as a five-year schedule. The curriculum follows in Table X.[13]

Completion of the Philippine Normal School.—Graduates of the Philippine Normal School academic course form Group VIII and are admitted to the Bachelor of Science curricula conditioned in Mathematics 3, but with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English IV	10	English 4	5
School management	5	Elective	20
History of education	5		
Practice teaching II	10		

Group VIII should complete the Bachelor of Science curriculum in the regular four years or in three years if they take maximum advantage of the summer sessions.

Completion of fourth year.—Students who have completed with satisfactory ratings the fourth year of the Philippine Normal School, academic course, form Group VIII 4 and are admitted to the Bachelor of Science curriculum conditioned in Mathematics 3, and Physics 1. They should complete the curricula in the usual four years by taking maximum advantage of summer sessions.

Completion of third year.—Students who have completed with satisfactory ratings the third year of the Philippine Normal School form Group VIII 3 and are admitted to the Bachelor of Science curriculum conditioned in Mathmatics 2 and 3, Physics 1 and Rural Economics 1. They should complete the curricula in five years by taking maximum advantage of the summer sessions.

[13] From the Office of the Superintendent of the Philippine Normal School.

TABLE X.—*Curriculum of the academic course of the Philippine Normal School.*

Year.	Subjects.	Semesters.	Periods a week.a	Units.b
First.... (General high schools)	English composition H. S. I..........	Both	5	10
	English literature H. S. I..............	Both	4	8
	Current events H. S. I..........	Both	1	2
	United States history....................	Both	3	6
	United States government..............	Both	2	4
	Elementary algebra......................	Both	5	10
	Military drill............................	Both	2	c
	Group games and athletics.........	Both	3	c
Second... (First of the P. N. S.)	English I (and current events).....	Both	5	10
	Reading methods and story telling. .	Both	5	10
	General history I............	Both	5	10
	Physical geography.........	First	5	5
	Geography methods........	Second	5	5
	Industrial work	Both	2+3Dd	10
	Music I.....................	Both	2	
Third.. (Second of the P. N. S.)	English II (and current events)..	Both	5	10
	Drawing..............	Both	5Dd	10
	Music II	Both	3	6
	Writing..........	Both	2	4
	Arithmetic methods..........	Both	5	10
	Biology................	Both	5Dd	10
Fourth.... (Third of the P. N. S.)	English III (and current events).	Both	5	10
	Physiology, hygiene, and sanitation .	First	5	5
	Philippine history and government. .	Second	5	5
	Psychology............	First	5	5
	General methods	Second	5	5
	Plane geometry..........	Both	5	10
	Observation and practice teaching I	Both	5Dd	10
Fifth..... (Fourth of the P. N. S.)	English IV..............	Both	5	10
	School management....... .	First	5	5
	History of education........	Second	5	5
	Economic conditions..........	Both	5	10
	Physics..................	Both	5Dd	10
	Practice teaching II.............	Both	5Dd	10
All......	All subjects.....................	......	......	240

a Periods are of 40 minutes duration unless otherwise noted

b One period a week for one semester equals one unit.

c Informal credit.

d D indicates double or laboratory periods of 80 minutes duration but equivalent to one regular period in unit value.

Completion of second year.—Students who have completed with satisfactory ratings the second year of the Philippine Normal School form Group VIII 2 and are admitted to the preparatory curricula with advanced standing as follows:

H. S. subjects.	*H. S. units.*	*Credited as*	*C. A. units.*
English composition H. S. I. . .	10	English 1.	10
English P. N. S. I.	10	English 2.	10
Elementary algebra.	10	Mathematics 1.	10

Group VIII 2 should complete the preparatory curriculum in one year, after which they may enter the Bachelor of Agriculture curriculum which they should complete in the regular four years. All students in Group VIII 2 are registered during the fourth year of their Bachelor of Agriculture curriculum in the supplementary curriculum, thus forming also Group VII 2S. They are given advanced standing in the supplementary curriculum as follows:

H. S.+P. N. S. subjects.	*H. S.+P. N. S. units.*	*Credited as*	*C. A. units.*
English literature I.	8	Supplementary English.	10
Current events I.	2		
United States history.	6	Supplementary history.	20
United States government.	4		
General history I.	10		
Reading methods and story telling. .	10	Supplementary academic.	20
Physical geography.	5		
Geography methods.	5		
Industrial work, Music I.	10	Supplementary technical.	10

The advanced standing scheduled above amounts to the entire requirement of the supplementary curriculum with the result that Group VII 2S automatically completes the supplementary curriculum simultaneously with the Bachelor of Agriculture curriculum. Consequently Group VIII 2+2S is recommended only for the one degree, Bachelor of Science in Agriculture.

Completion of the first year.—The first year of the academic course in the Philippine Normal School is not given in that institution but consists of the first year of the general high school curriculum, for articulation with which, *see* under Group I 1 on page 498.

SUMMARY OF CATEGORIES

Summarizing all categories, regular and special, Table XI is presented.

CONCLUSIONS

From a review of entrance conditions and advanced standing credits allotted to various groups of matriculants in the College of Agriculture, it is apparent that a complete, though somewhat complex, mechanism has been developed whereby the College may articulate its various curricula with practically every type of secondary school in the Philippine system, with the different years thereof and with the intermediate schools.

The broad entrance policy in the College has been maintained with the constant end in view of popularizing agricultural technical education without lowering the collegiate standards.

Upper-end articulation of the College, as well as the adopted standards, have been maintained in the College by virtue of the supplementary curriculum which forms the elastic element in what would otherwise be a very rigid set of curricula.

TABLE XI.—*Summary of categories of students admitted to the College of Agriculture with their conditions and advanced standing credits.*

Group.	Received from:			College of Agriculture curriculum to which admitted.	Conditioned in:		Advanced standing in:		Degree conferred.
	Institution.	Course.	Yrs.		Subjects.	Units.	Subjects.	Units.	
I	High school	General	4	Bachelor of Science					Bachelor of Science in Agriculture.
I-ST	High school	General	4	Sugar Technology					Bachelor of Science in Agriculture with Certificate in Sugar Technology.
I-3	High school	General	3	Bachelor of Science	Physics 1 Rural economics 1	6 4			Bachelor of Science in Agriculture.
I-2	High school	General	2	Preparatory			English 1, 2 Mathematics 1, 2	20 20	
	College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
I-2S	College of Agriculture ex 2nd yr. general	B. Agr.	4	Supplementary			English History Academic	10 20 10	Bachelor of Science in Agriculture.
I-1	High school	General	1	Preparatory			English 1 Mathematics 1	10 10	
	College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
I-1S	College of Agriculture ex 1st yr. general	B. Agr.	4	Supplementary			English History	10 10	Bachelor of Science in Agriculture.
II	Intermediate school	All	3	Preparatory.					
	College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
II-S	College of Agriculture ex intermediate	B. Agr.	4	Supplementary					Bachelor of Science in Agriculture.
III	High school	Agric.	4	Bachelor of Science	Mathematics 1, 2, 3 Physics 1	25 6	Agronomy 1 Farm experience A, B, C	4 a	Bachelor of Science in Agriculture.
III-3	High school	Agric.	3	Bachelor of Science	Mathematics 1, 2, 3 Physics 1 Rural economics 1	25 6 4	Agronomy 1 Farm experience A, B, C	4 a	Bachelor of Science in Agriculture.
III-2	High school	Agric.	2	Preparatory.			English 1, 2 Plant Physiology 1 Agronomy 1 Farm experience A, B, C	20 8 4 a	
	College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
III-2S	College of Agriculture ex 2nd yr. agricultural	B. Agr.	4	Supplementary			Academic Technical	10 10	Bachelor of Science in Agriculture.
III-1	High school	Agric.	1	Preparatory			English 1 Agronomy 1 Farm experience A, B, C	10 4 a	
	College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
III-1S	College of Agriculture ex 1st yr. agricultural	B. Agr.	4	Supplementary			Academic	10	Bachelor of Science in Agriculture.
IV	High school	Commercial.	4	Bachelor of Science	Mathematics 3. Plant Physiology 1 Physics 1	5 8 6			Bachelor of Science in Agriculture.
IV-3	High school	Commercial.	3	Bachelor of Science.	Mathematics 3 Plant Physiology 1 Physics 1 Rural economics 1	5 8 6 4			Bachelor of Science in Agriculture.
V	High school	Trade	4	Bachelor of Science	Plant Physiology 1	8	Mathematics 5, 6 Farm experience B, C	6 a	Bachelor of Science in Agriculture.
V-3	High school	Trade	3	Bachelor of Science	Plant Physiology 1 Physics 1 Rural economics 1	8 6 4	Farm experience B, C	a	Bachelor of Science in Agriculture.
V-2	High school	Trade	2	Preparatory			English 1, 2 Mathematics 1, 2 Farm experience B, C	20 20 a	
	College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
V-2S	College of Agriculture ex 2nd yr. trade	B. Agr.	4	Supplementary			English History. Technical	10 10 10	Bachelor of Science in Agriculture.
V-1	High school	Trade	1	Preparatory			English 1. Mathematics 1. Farm experience B, C	10 10 a	

College of Agriculture	Prep.	2	Bachelor of Agriculture.					Bachelor of Agriculture.
College of Agriculture ex 1st yr. trade	B. Agr.	4	Supplementary			English.	10	Bachelor of Science in Agriculture.
High school	2-Yr. Normal.	2	Preparatory			English 1, 2	20	
College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
College of Agriculture ex 2nd yr. 2-yr. normal	B. Agr.	4	Supplementary			English History Academic	10 10 30	Bachelor of Science in Agriculture.
High school	2-Yr. Normal.	1	Preparatory			English 1.	10	
College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
College of Agriculture ex 1st yr. 2-yr. normal	B. Agr.	4	Supplementary			English History Academic Technical	10 10 10 10	Bachelor of Science in Agriculture.
High School	4-Yr. Normal.	4	Bachelor of Science in Agriculture	Mathematics 2, 3 Physics 1	15 6			Bachelor of Science in Agriculture.
High school	4-Yr. Normal.	3	Bachelor of Science in Agriculture	Mathematics 2, 3 Physics 1 Rural economics 1	15 6 4			Bachelor of Science in Agriculture.
High school	4-Yr. Normal.	2	Preparatory			English 1, 2 Mathematics 1	20 10	
College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
College of Agriculture ex 2nd yr. 4-yr. normal	B. Agr.	4	Supplementary			English History Academic Technical	10 20 20 10	Bachelor of Science in Agriculture.
High school	4-Yr. Normal.	1	Preparatory			English 1	10	
College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture.
College of Agriculture ex 1st yr. 4-yr. normal	B. Agr.	4	Supplementary			English History Academic Technical	10 10 10 10	Bachelor of Science in Agriculture.
Philippine Normal School	5-Yr. Normal.	5	Bachelor of Science in Agriculture	Mathematics 3	5	English 4 Elective	5 20	Bachelor of Science in Agriculture.
Philippine Normal School	5-Yr. Normal.	4	Bachelor of Science in Agriculture	Mathematics 3 Physics 1	5 6			Bachelor of Science in Agriculture.
Philippine Normal School	5-Yr. Normal.	3	Bachelor of Science in Agriculture	Mathematics 2, 3 Physics 1 Rural economics 1	15 6 4			Bachelor of Science in Agriculture.
Philippine Normal School	5-Yr. Normal.	2	Preparatory			English 1, 2 Mathematics 1.	20 10	
College of Agriculture	Prep.	2	Bachelor of Agriculture					Bachelor of Agriculture
College of Agriculture ex 2nd yr. P. N. S.	B. Agr.	4	Supplementary			English History Academic Technical	10 20 20 10	Bachelor of Science in Agriculture.

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